PROCEEDINGS

Seventy-Seventh Annual Convention

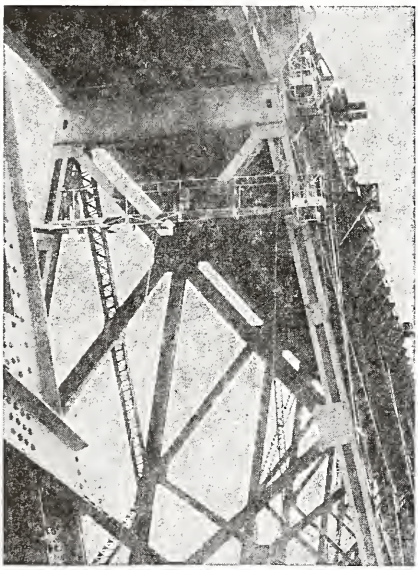
OF THE

American Railway

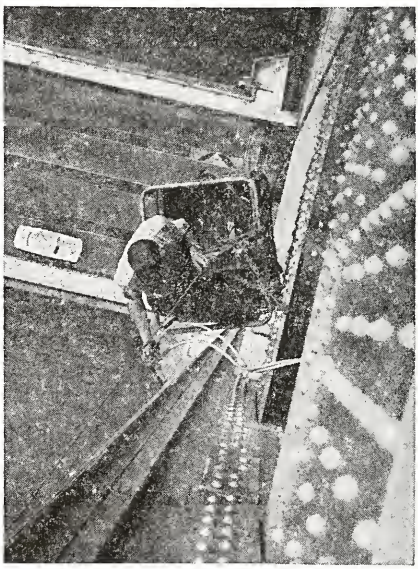
Bridge & Building Association

1972

THE HIGH ROAD—Painting as he goes this painter walks a Spider Staging along a main cable of the Chesapeake Bay Bridge.



40% SAVED—The Chicago and North Western Railroad, through the use of modern material and equipment, reduced their bridge painting costs by 40%.



FROM TOP TO BOTTOM—A bird's eye view of a Tower painter in a Spider Staging, 550 feet above Puget Sound, on the Tacoma Narrows Bridge.

RENTAL AND SALES

Spider Staging Sales Co.

P. O. Box 182 Renton, Washington 98055

PHONE: ALpine 5–8267

Proceedings of the

Seventy-Seventh Annual Convention

of the

American Railway
Bridge & Building
Association

749.4650

Held at

CHICAGO, ILLINOIS

September 18-20, 1972

Published by the Association
18154 Harwood Ave., Homewood, Ill. 60430
R. E. Dove, Editor

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OFFICERS FOR 1972

T. L. Fuller ..... President
Southern Pacific Transportation Co.

N. D. Bryant ..... First Vice President
St. Louis-San Francisco

E. E. Runde ..... Second Vice President
Illinois Central

J. J. Ridgway ..... Third Vice President
Bessemer & Lake Erie

W. H. Huffman ..... Treasurer
Chicago & North Western

Ann Wilson ..... Secretary
18154 Harwood Ave., Homewood, Ill. 60430

DIRECTORS

Term Expires 1972

J. W. Chambers, Misouri Pacific ..... St. Louis, Mo.

R. E. Frame, Southern Pacific Transportation Company ..... Houston, Tex.

J. C. Hobbs, Richmond, Fredericksburg & Potomac ..... Richmond, Va.

Term Expires 1973

R. K. Corbett, Atchison, Topeka & Santa Fe ..... San Bernardino, Calif.

J. R. Iwinski, Burlington Northern ..... Chicago, Ill.

J. S. Pritchett, Southern ..... Savannah, Ga.

Term Expires 1974

D. C. Gould, Union Pacific ..... Omaha, Neb.

W. S. Stokeley, Illinois Central ..... Chicago, Ill.

W. C. Sturm, Elgin, Joliet & Eastern ..... Joliet, Ill.

PAST PRESIDENT

A. R. Dahlberg ..... Amarillo, Tex.
Atchison, Topeka & Santa Fe

OFFICERS FOR 1973

N. D. Bryant ..... President
St. Louis-San Francisco

E. E. Runde ..... First Vice President
Illinois Central Gulf

J. J. Ridgeway ..... Second Vice President
Bessemer & Lake Erie

J. R. Williams ..... Third Vice President
Chicago, Rock Island & Pacific

W. H. Huffman ..... Treasurer
Chicago & North Western

Ann Wilson ..... Secretary
18154 Harwood Ave., Homewood, Ill. 60430

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D. C. Gould, Union Pacific ..... Omaha, Neb.
W. S. Stokeley, Illinois Central Gulf ..... Chicago, Ill.
W. C. Sturm, Elgin, Joliet & Eastern ..... Joliet, Ill.

Term Expires 1975

J. W. Davidson, Burlington Northern ..... St. Paul, Minn.
C. A. Hughes, Southern Pacific Transportation Corp. ..... San Francisco, Calif.
W. R. Hyma, Atchison, Topeka & Santa Fe ..... Chicago, Ill.

PAST PRESIDENT

T. L. Fuller ..... San Francisco, Calif.
Southern Pacific Transportation Co.

Memoir

J. L. Varker

1895-1972

J. L. Varker, retired special engineer of the Delaware & Hudson Railroad, died October 31, 1972 at Carbondale, Pa., at the age of 77.

Mr. Varker was born at Alden Station, Pa., on April 10, 1895.

He entered railroad service in September 1914 as a timekeeper on the construction of the Wilkes-Barre Connecting Railroad, becoming a chainman in July of the following year. Upon completion of this project, he resigned February 1918 to go with the Central Railroad of New Jersey as a draftsman at Wilkes-Barre. On August 16, 1920 he left to join the Delaware & Hudson as a draftsman at Carbondale. The following year he was appointed transitman and in 1924 was promoted to senior transitman. On September 1, 1927, he was appointed assistant engineer at Scranton, Pa., during the construction of a grade-separation project within that city. Upon completion of that work, he returned December 1, 1928 to his former position of senior draftsman at Carbondale. On April 16, 1930, he was advanced to supervisor of bridges and buildings with the same headquarters. In 1949, he was appointed division engineer there and, in 1956, to special engineer at Albany, N.Y., which was the position he held at the time of his retirement in 1958.

Mr. Varker became a member of the ARB&BA in December 1936. He became a director of the Association in October 1941 and, the following year he was moved up to Fourth Vice President. In October 1943, he was elected President. He has the distinction of being one of the two Presidents who served more than one term, serving until October 1945.

PROCEEDINGS

77th Annual Convention

September 18-20, 1972

Conrad Hilton Hotel, Chicago, Ill.

The 77th Annual Convention of the American Railway Bridge & Building Association was held September 18-20, 1972 at the Conrad Hilton Hotel, Chicago. For the 27th year it was held concurrently with the Annual Meeting of the Roadmasters' & Maintenance of Way Association.

As has been the usual custom, the mornings of the first two days of the meeting were joint sessions with the Roadmasters', and the afternoons of those two days and the morning of the third day were held as separate sessions.

Total registration for the joint convention was 706, which is about the same attendance as the preceding year. Both yearly conventions were non-exhibit years.

The joint session on Monday was the opening session and, in addition to an invocation by Dr. Kenneth Hildebrand, pastor of the Central Church in Chicago, greetings from R. M. Brown, president, AREA, and R. G. Wade, president Railway Engineering – Maintenance Suppliers Association, and remarks by L. A. Grego, first vice president, REMSA, the program included the keynote address by B. F. Biaggini, president, Southern Pacific Transportation Co., San Francisco, Calif., and addresses on "Update on OSHA" by Charles J. Wolff, technical advisor, industry, Occupational Safety & Health Administration, and on "Modifications to FRA Track Safety Standards," by John E. Rourke, director, Safety Act Task Force, Federal Railroad Administration.

At the morning joint session on Tuesday, addresses were delivered on "The Financial Problems of the Railroad Industry, Particularly Those Railroads in the East," by W. P. Coliton, president, Western Maryland, on "The Construction of Black Mesa & Lake Powell Railroad," by J. F. Pearce, project director, Morrison-Knudson, and on "Safety Is No Accident," by G. M. Leilich, vice president – operations, Western Maryland.

Separate Sessions

The separate B & B sessions were presided over by T. L. Fuller, president and engineer of bridges, Southern Pacific. The session on Monday afternoon included an address and report on the state of the Association by President Fuller; recognition of Past Presidents, a committee report on Cast-In-Drilled-Hole Concrete Piling, an address on "Geophysical Exploration of Subsoil Conditions," by Karl R. Horner, manager, Geophysical Department of Hoskins, Western, Sonderegger, and an address on "Care and Use of Wire Rope and Slinging," by Norbert Freeborn, Broderick & Bascomb Wire Rope Co.

The Tuesday afternoon B&B session included two committee reports, and addresses on "Metal Buildings—Present and Future," by W. F. Eldridge, Metal Products Division of Armco Steel Corp., on "The Illinois Central's New Bridge Across Pass Manchac," by D. S. Beehly, assistant chief engineer—structures, Illinois Central Gulf, and

on "Use of Laminated Timber Stringers in Railroad Bridges," by Donald O. Barth, manager, engineering and computer sciences, Laminated Products Department, Koppers Co., Inc.

The last separate session on Wednesday morning included one committee report, a moving picture on "Progress in Prestressed-Concrete Railroad Bridges Using Prestressed Elements," the business session and the election and installation of officers.

Election of Officers

The officers and directors elected and installed by the Association for the 1972-73 period are:

President: N. D. Bryant, assistant bridge engineer – construction and maintenance, Frisco, Springfie'd, Mo.

First Vice President: E. E. Runde, manager construction, Illinois Central Gulf, Chicago, who moved up from First Vice President.

Second Vice President: J. J. Ridgeway, project manager, Bessemer & Lake Erie, Greenville, Pa., who advanced from Third Vice President.

Third Vice President: J. R. Williams, engineer bridges, Rock Island, Chicago.

Treasurer: W. H. Huffman, assistant vice president and chief engineer, North Western, Chicago.

Secretary: Mrs. Ann Wilson, 18154 Harwood Avenue, Homewood, Ill.

Directors: J. W. Davidson, assistant director bridge engineering, Burlington Northern, St. Paul, Minn.; C. A. Hughes, assistant engineer bridges, Southern Pacific San Francisco, Calif.; and W. R. Hyma, bridge engineer, Santa Fe, Chicago.

Secretary's Report

Report of Membership for Period September 8, 1971 to September 15, 1972

ACTIVE MEMBERSHIP:			
Total Active Members, September 8, 1971		491	
New Active Members since September 8, 1971		34	
Reinstated—Paid back dues		4	
			529
LESS—Transferred to Life Membership	8		
Resigned Account Retirement, etc.	16		
Reported deceased	5		
Transferred to Associate	1		
Dropped for non-payment of dues	30	60	
TOTAL ACTIVE MEMBERS			469
ASSOCIATE MEMBERS:			
Total Associate Members, September 8, 1971		75	
New Associate Members since September 8, 1971		8	
Transferred from Active to Associate		1	
		84	
LESS—Resigned account retirement, etc.	4		
Reported deceased	1		
Dropped for non-payment of dues	3	8	
TOTAL ASSOCIATE MEMBERS			76

LIFE MEMBERS:		
Total Life Members—September 8, 1971	145	
Transferred from Active to Life Membership	8	
	153	
LESS—Reported Deceased	7	
Transferred to Honorary	1	8
TOTAL LIFE MEMBERS		145
HONORARY MEMBERS:		
Total Honorary Members—September 8, 1971	8	
Transferred from Life to Honorary	1	
TOTAL HONORARY MEMBERS		9
TOTAL MEMBERSHIP—ALL CLASSES—SEPTEMBER 15, 1972		699

Treasurer's Report

Period September 1, 1971 to August 31, 1972

Balance August 31, 1971		$8,814.56
RECEIPTS:		
Dues	$3,092.15	
1970 Advertising	2,591.92	
1971 Convention Registration Fee	339.19	
1971 Advertising	8,663.77	
Miscellaneous	10.00	14,697.03
TOTAL RECEIPTS		$23,511.59
DISBURSEMENTS:		
Salaries (Secretary and Assistant)	$2,467.50	
FICA (On payroll)	128.53	
Stationery and Printing	598.46	
Office Rent, Telephone, Etc.	523.72	
Postage	461.57	
Office Supplies	83.84	
1970 Advertising	2,142.20	
1971 Advertising	3,237.34	
1971 Convention Expenses	71.44	
Miscellaneous	279.45	
1971 Proceedings	2,561.29	
Funds transferred to Homewood Savings & Loan Assn.	4,000.00	
Director of Labor, State of Ill., Unemployment Tax	33.48	
Return of Guarantee to American Publishing Co.	3,500.00	$20,088.82
BALANCE—AUGUST 31, 1972		$ 3,422.77
HOMEWOOD FEDERAL S/L (#24294)		7,317.87
		$10,740.64

September 7, 1972

APPROVED: E. R. SCHLAF, *Chairman*
H. M. WILSON
H. F. LUCAS

Report of Auditing Committee

TO MEMBERS OF THE

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION:
Gentlemen:

The undersigned have examined the books of the Secretary and report of the Treasurer for the period from September 1, 1971 to August 31, 1972, inclusive, and have found them to be correct as of the latter date.

Respectfully submitted,
E. R. Schlaf, *Chairman*
H. F. Lucas
H. M. Wilson
September 7. 1972

Report of Necrology Committee

1971 - 1972

To the President and Members of the

AMERICAN RAILWAY BRIDGE & BUILDING ASSOCIATION

It is with grief and regret that we report the known loss of members (13) through death during the past year. It is possible that other members have passed away during the year of whom we have no information. If you know of any, please report their names to the Secretary. The following have been reported since our last Annual Meeting in September 1971.

ACTIVE MEMBERS	TITLE—LOCATION	JOINED	DECEASED
J. G. Greenlee	Clearance Engineer Penn Central Trans. Co. Philadelphia, Pa.	1961	1971
W. C. Howe	Director Engineering Serv. Bessemer & Lake Erie R.R. Greenville, Pa.	1959	1972
T. A. Myrind	Bridge & Building Supervisor Southern Pacific Co. West Oakland, Calif.	1964	1971
R. W. Meyers	Carpenter Foreman Penn Central Trans. Co. Columbus, Ohio	1967	1972
A. Fejes	Bridge & Building Foreman Illinois Central R.R. Chicago, Ill. 60605	1967	1972
ASSOCIATE MEMBER			
T. P. Davidson	Secretary Globe Chemical Co. Lombard, Ill.	1955	1971

LIFE MEMBERS	TITLE—RAILROAD	JOINED	DECEASED
R. D. Anderson	Division Engineer Chicago & Northwestern Ry. Redfield, S. Dakota	1923	1972
J. H. Babbitt	Asst. Division Engineer Baltimore & Ohio R.R. Indianapolis, Ind.	1946	1970
F. J. Duffie	Service Representative Linde Air Products Co. Sterling, Ill.	1946	1971
F. Duresky, Jr.	Bridge & Building Supervisor Chicago & North Western Ry. Huron, S. Dakota	1942	1971
V. W. Hutchings	Bridge & Building Supervisor Southern Pacific Co. Fresno, Calif.	1941	1972
A. Pfeiffer	Bridge & Building Supervisor Southern Pacific Co. Sacramento, Calif.	1939	1971
D. T. Rintoul	General Bridge Inspector Southern Pacific Co. Victorville, Calif.	1910	1972
J. L. Varker	Special Engineer Delaware & Hudson RR Carbondale, Pa.	1936	1972

Respectfully submitted
R. K. Corbett, *Chairman*

Report of Resolutions Committee

Mr. President, at the close of this 77th Annual Convention of the American Railway Bridge and Building Association, the Resolutions Committee offers the following resolutions:

BE IT HEREBY RESOLVED that the thanks of this Association be extended to Dr. Kenneth Hildebrand for his message of spiritual assurance.

BE IT FURTHER RESOLVED that the thanks of the Association be expressed to the several prominent speakers who gave of their time and so capably shared their wisdom and counsel with us, especially AREA President, Mr. R. M. Brown; Director, Safety Act Task Force, Federal Railroad Administration, Mr. John E. Rourke; President, Southern Pacific Transportation Company, Mr. B. F. Biaggini; Technical Advisor, Industry, Occupational Safety and Health Administration, Mr. Charles Wolff; President, Western Maryland Railway, Mr. W. P. Coliton; Vice President, Operations, Western Maryland Railway, Mr. G. M. Leilich; Project Director, Morrison-Knudsen, Mr. J. F. Pearce.

BE IT ALSO RESOLVED that the Association express its appreciation to REMSA and to REMSA President, Mr. R. G. Wade, and his staff who so generously provided us with the most splendid banquet and evening of entertainment.

BE IT FURTHER RESOLVED that our thanks be expressed to Mrs. T. L. Fuller, Mrs. R. R. Gunderson and Mrs. R. G. Simmons, and their committees, for their efforts in arranging registration and entertainment for our wives, and to the untiring efforts of the ladies who assisted in registration.

AND, BE IT FINALLY RESOLVED that the Association express its thanks to its Chairmen and their committees for their fine work in preparing the reports which were presented at the convention, also to Simmons-Boardman Publishing Corporation and its representatives for their capable assistance, to the A.R.E.A., to the Chicago, Rock Island and Pacific Railroad Company and to the Santa Fe Railway who provided assistance at the registration desk, to the management and staff of the Conrad Hilton Hotel for their attentive cooperation and warm hospitality, as well as to the members of our executive committee and to our President, Mr. T. L. Fuller, who has spent so much of their own personal time and effort in guiding the affairs of our Association over the past year.

Mr. President, we recommend these resolutions be made a part of the official record of this association, and that copies be presented to all concerned parties.

Respectfully submitted,
J. R. Iwinski, *Chairman*

President's Address

By T. L. Fuller

Engineer Bridges, Southern Pacific, San Francisco, Calif.

T. L. Fuller

Our By-Laws impose upon the President an obligation to report to the membership on the general condition of the affairs of the Association. This can briefly be condensed into two areas, namely finances and membership. It is my pleasure to report that our financial condition continues to be good. Our Treasurer, Mr. Huffman, will present a detailed report during our business session on Wednesday morning. Our good financial condition continues to be due to the utilization of a professional agency to solicit our advertising, which is our main source of revenue. The activity of this professional agency has permitted us to retain our $7.00 annual dues, whereas the Roadmasters' dues are $10.00.

Our membership, however, is a serious problem. Our total membership reached its all-time high in 1963, with 968 members of all classes. Our membership as of September 1972 was a total of 704 members or 27% below our all-time high. We have been showing slight improvement the last few years, namely from 709 in September 1970 to 719 in September 1971, however, we have dropped to 704 today. We have had an increase in the Associate Member category, and we desperately need additional active members. There are many circumstances contributing to the decline in active members, such as consolidation of divisions, mergers that reduce the number of supervisory personnel and general economic conditions of our industry. All of these are problems. However, I am sure that most of you know of potential members, either new employees or recently promoted men that are eligible for membership. I urge each of you to endeavor to sign up a new member.

I would like to remind you that the work of this Association is accomplished through the purely voluntary efforts of its members. If you feel you have a contribution to make toward the betterment of the Association, please do not hesitate to step forward. We welcome comments and suggestions from the membership.

I sometimes wonder if the general membership ever takes a moment to consider the tremendous efforts required to plan, organize and run a convention such as this. These well-planned meetings do not just happen—they are the result of a great deal of work by the Board of Directors and the Executive Secretary. At the conclusion of the Convention, each member of the Board is appointed to one or more of our committees and given other tasks which require a great deal of attention. Without their cooperation and work, a successful convention and an effective Association would not be possible. At this time, I would like to introduce the members of our Executive Committee. I will appreciate it if they will stand when introduced

and remain standing until all have been introduced. Please withhold your applause until all have been made known.

I shall begin with our three Junior Directors: (1) Mr. D. C. Gould, system bridge supervisor, Union Pacific, Omaha, Nebraska. Don is a member of our Advertising Committee. (2) Mr. W. S. Stokeley, designer, Illinois Central Gulf, Chicago, Illinois. Bill is a member of our Membership Committee and Registration Desk Committee. (3) Mr. W. C. Sturm, senior design engineer, Elgin, Joliet & Eastern Railway, Joliet, Illinois. Wally is a member of the Necrology Committee. In addition to the committee assignments, these three gentlemen have served as sponsors for the three special committee reports to be presented at this meeting.

Our intermediate group of Directors are next. They are (1) Mr. R. K. Corbett, general foreman B&B and water service, Atchison, Topeka and Santa Fe, San Bernardino, California. Bob is Chairman of the Necrology Committee and is also assigned to our Special Subjects Committee. Due to an emergency, Bob is not with us at this meeting. (2) Mr. J. R. Iwinski, bridge & building engineer, Burlington Northern, Chicago. Jerry is Chairman of that very important committee, the Ladies Entertainment Committee and also Chairman of the Resolutions Committee, (3) Mr. J. S. Pritchett, general bridge & building supervisor, Southern Railway, Savannah, Georgia. Jim is Chairman of the Registration Desk Committee and a member of the Resolution Committee.

Our Senior Directors are (1) Mr. J. W. Chambers, bridge construction engineer, Missouri Pacific, St. Louis, Missouri. Joe is sponsor of Standing Committee No. 2, Tools Equipment for B&B Work. (2) Mr. R. E. Frame, district engineer, Southern Pacific, San Francisco, California. Russ is Chairman of the Public Relations and Convention Greeting Committee and member of the Convention Program Committee. (3) Mr. J. C. Hobbs, engineer track & structures, Richmond, Fredricksburg and Potomac, Richmond, Virginia. Jim is sponsor of Standing Committee No. 1, New Materials for B&B Work and a member of the Ladies Entertainment Committee.

I will now introduce the officers serving during the year. First is our Third Vice President, Mr. J. J. Ridgeway, project engineer, Bessemer & Lake Erie, Greenville, Pennsylvania. John is chairman of our Special Subjects Committee, and the excellent program of our meeting is largely due to his efforts. Our Second Vice President is Mr. E. E. Runde, manager of construction, Illinois Central, Chicago. Erv is, and has been for several years, Chairman of our Advertising Committee. I now wish to present Mr. N. D. Bryant, assistant bridge engineer, St. Louis-San Francisco Railway, Springfield, Missouri. Darryl is chairman of our important Membership Committee.

Also seated at the speakers table is our Treasurer, Mr. W. H. Huffman, assistant vice president and chief engineer, Chicago & North Western, Chicago, Illinois. Heinie is also one of our esteemed past Presidents. We are very appreciative of his efforts on behalf of our Association.

You may now applaud this fine group.

(Applause) Thank you. Gentlemen, you may now be seated.

I would like, at this time, to acknowledge the services rendered the Association by three gentlemen seated in the audience. Mr. Merwin Dick is vice president and editor of Railway Track & Structures and has for many years been Chairman of our Program Committee. The excellent reports and speakers you will see and hear are largely the result of his efforts. Merwin is also one of our past Presidents. Mr. Bob Dove is associate editor of Railway Track & Structures. Bob has the responsibility for editing and pub-

lishing our proceedings and serves as a consultant on our Hotel Arrangements Committee. Bob is also a past President. Both Merwin and Bob are Honorary Members of the Association. The third man I would like to introduce is Mr. W. F. Armstrong, Engineer of Buildings, Chicago & North Western, Chicago. Bill is Chairman of the Hotel Arrangements Committee and also represents our Association in the Administration of the Secretary's office, which is a joint office serving the B&B, Roadmasters' and Superintendents Associations. Bill also gets out the quarterly newsletters. Bill is also a past President. It is difficult to see how the affairs of our Association could function without the activities of these three men. Will they please stand and be recognized.

I would also like to introduce our Secretary, Mrs. Ann Wilson. However, her duties at the Registration Desk prevent her appearance here at this time. She will, however, appear at our business session on Wednesday morning to present her report.

In the event that there are individuals present whom I have failed to introduce, please bring it to my attention. The omission was purely an oversight on my part.

In conclusion, I wish to express to the membership my sincere appreciation for allowing me to serve as your President during the past year. I consider it a privilege and an honor to have been so selected. The experience has been of great personal satisfaction to me and I hope that my term has been equally as gratifying to you.

Thank you for your attention.

Introduction of B. F. Biaggini

President Fuller: It is now my pleasure to introduce our keynote speaker, Mr. Benjamin F. Biaggini, president and chief executive officer of the Southern Pacific Company.

Mr. Biaggini graduated from St. Mary's University in San Antonio Texas, and almost immediately entered railroad service with the Southern Pacific as a rodman. He rose through various positions in the Engineering Department, ultimately to the position of chief engineer, before being promoted to the Executive Department as vice president, first at Houston, then at San Francisco, and soon thereafter to president and chief executive officer at San Francisco.

In addition to directing the affairs of Southern Pacific, Mr. Biaggini manages to find time to be a member of the Business Council, trustee of the Conference Board, director and member of the Executive Commitee of the AAR, trustee of the California Institute of Technology, be active in the Chamber of Commerce, the National Safety Council, Bay Area Council, Bay Area United Crusade, and many other clubs and organizations. He was appointed by President Nixon to the National Pay Board from its inception until its restructuring last March. In his spare time he is an avid golfer.

I would now like to present Mr. B. F. Biaggini. (Applause)

'Good News' and 'Bad News' of Railroad Industry

By B. F. Biaggini
President, Southern Pacific Company

Thank you, Tommy, President Gunderson, President Fuller:

I see Dr. Hildebrand has taken advantage of your suggestion that he might leave before I began speaking. But I did want to give him greetings because I think he and I have been addressing organizations like this one on their opening day for some time and it's always great to see old familiar faces and old familiar friends. And, certainly, that I see in this audience.

I came in from San Francisco on a delayed flight yesterday evening because of the thunderstorms in the Chicago area. I know many of you suffered that same inconvenience. But the thing that really worried me was whether this crowd was going to be out patroling track or not. I guess we got by allright in the area because we do have a nice audience, President Fuller and President Gunderson, and it is a real pleasure for me to be with you here again.

It's a special pleasure for me to be a part of the meetings of groups such as this one. My first job on the railroad was as a rodman, and my first 15 years as a railroader were spent in the engineering part of the business. Because of this background, at least to a degree, your profession and the engineering and construction projects you carry out are of keen interest to me. Aside from the personal reference, the entire business of railroading is one which is highly dependent upon the skills and determination of the engineer, and the history of the industry and its achievements bears this out.

And so I am glad to participate in your program and to start it off as your keynoter with a little philosophy, a few suggestions, and—I hope—a little inspiration. At the same time I welcome the opportunity to recognize publicly the specialized knowledge and abilities which you maintenance men apply to your daily duties, and the dedicated manner in which you tackle your problems under a variety of conditions—ranging from the tedium of repetitive but necessary tasks to the hard extremes of weather and emergency which must be faced to keep our railroads open and running, no matter what.

B. F. Biaggini

And when I say you maintenance men, I don't want to overlook any of the ladies in the audience. If there are lady roadmasters, division engineers, B & B supervisors, I want you to be sure that my remarks apply equally well to you.

We had a family night gathering on the Southern Pacific up at Eugene, Ore., a few weeks ago. We had about 1,750 people present. And two of the guests were two young girls who are

trainees in our management program. They had been up on the Oregon Division seeing how we gather lumber and forest products on the branch lines up in that timber country. At that time, I suggested to the audience if they would take a look at these two girls, maybe the new assistant trainmaster at Medford was there. So, ladies, if you are here as participants in maintenance of way and bridge and building work, welcome to you and my greetings to you.

Gatherings like this provide an opportunity to pause and look at where we are in the long evolution of our industry—to note, as in the old jokes now making the rounds again, some of the "good news" and the "bad news." Consider some changes in railroad operations in the United States in the last ten years that are suggested by comparing 1971 AAR statistics with 1961 figures.

Have had a 25% increase

Average annual mileage for a freight car is up to 20,000 from 16,000, an increase of 25%. Average load per car is 55 tons versus 45 tons, another increase of about 25%. Average per-car capacity of the freight car fleet is up to 68 tons from 56 tons, an increase of 20%, and the average capacity of cars built last year was 85 tons. Freight train speeds have increased substantially, and average tonnage per train has climbed to 1800 versus 1500 tons, still another 20% increase. These comparisons confirm what we feel in our bones—that from a maintenance standpoint the operating environment is more severe, by roughly 25% over a decade ago.

And what is ahead for the decade of the 'seventies? Goals recently outlined by the industry for achievement by 1980 include reduction in scheduled origin-to-destination time by 20% under 1970 levels; provision of suitable equipment to meet 90% of all traffic demands; and reduction of damage claims by 50% below 1970 experience. Can there be any doubt that the demands on our railroad plants are going to increase still further? To voice just one of a dozen questions we could raise at this point, is our new ten-year study of track-train dynamics, which Southern Pacific is leading, going to produce enough information fast enough to meet the needs of heavier, faster trains on more reliable schedules?

Our railroads are in a struggle both to preserve and to improve their share of the growing intercity freight transportation market against vigorous competition. As the federal interstate highway system nears completion, even greater competition from trucks can be anticipated. We see campaigns underway to increase the allowable truck loadings and to permit triple trailers to operate. If railroads don't continue to improve, such developments could result in further diversion of high-rated tonnage to rubber-tired carriers. We improve our productivity in our terminals at great expense for facilities which must be paid for before they are placed in operation. The Federal Highway Administration puts a new bypass route in service around a congested city and immediately the productivity of every truck using that new route is improved, without the owners having been required to put up one dime in new capital funds.

Need funds for capital expenditures

But the really "bad news" is that the railroad industry as a whole still is not earning an adequate return on its investment to insure a flow of needed capital at reasonable rates. Returns of under 3% continue to restrict our ability to obtain funds for the new locomotives, cars and plant upgrading needed to meet the increased competition while still meeting the same general economic problems other businesses face. We are dependent upon a wider variety of physical facilities than

other forms of transportation. Tracks, yards, cars, power, terminals, signals, communications—just name it and we need it, and it all costs money. But where we have a modern plant there is no doubt that we can perform a more economical job of transportation than any of our principal competitors.

In our complex mix of "good news" and "bad news" we have some items that are hard to label just yet. We have the federal track standards. You are familiar with these—the original proposals and the revised version. These standards are going to have their effect on the various railroad properties, to a greater extent on some than on others.

We have Amtrak. Its creation has relieved the railroads of an uneconomical operation, which is "good news." But if Amtrak does not successfully rationalize the rail passenger problem we may face the "bad news" of being blamed for its failure by some obscure reasoning process.

We have the Interstate Commerce Commission. There is "good news" in its growing awareness that railroads are no longer a monopoly and that diversification is desirable. But there is still "bad news" in the slow and uncertain pace of its decisions and administration.

We have our excellent efforts to achieve longneeded legislative action to correct old inequities through implementation of the ASTRO Report. There is "good news" in the agreement between railroad, truck and waterway carriers to stand together on the Surface Transportation Act, but there is "bad news" in the hazard of lack of any final actions by the Congress in this election year.

Tonnage will double in 10 years

To mention just one more of the two-sided considerations, we have the forecasts that freight tonnage will be about double 1970's volume by the 1980's. This is "good news" for the traffic and financial outlook, but I recognize that in the short term it may be viewed as "bad news" if you are a roadmaster or bridge supervisor who cannot get track time now, although these are the kinds of problems we all want.

Finally, let's mention some "news" that is clearly "good" for this particular audience. DOT, FRA, the AAR and individual railroads are moving ahead with much-needed research on track, dynamics of train operations and better equipment for the future. The American capitalistic system, energized by the profit motive, has usually produced solutions for whatever mechanical problems have arisen, and I have full faith that successes will continue to be recorded. Technology is advancing by great strides, developing new methods and equipment for more efficient utilization of manpower. These are indeed "good news" items, but the best of all news we have going for us is the increasing skill of our people in this industry.

To use that skill to the utmost calls for the best communications—not just our new and remarkable machine communications, but old-time, man-to-man communications to reach good understandings department - to - department within one's own railroad, among railroads, between unions and management, between suppliers and railroads, and between government and railroads. That kind of communications becomes vital as soon as we realistically discard the now-untenable notion that any department of a truly dynamic modern railroad can operate like a closed corporation.

We live at a time full of "happenings" on every front—from the mechanical to the social, economic and political—and this audience is well aware of the pace of technical innovations. Your profession can be proud of past accomplishments in railroading, but its past is mere prologue to what you now must do with all this new information if the railroads are to continue to be, as they must, the steel backbone of our economy.

I assure you that the role of the railroad engineering department—of which you are all a part—is going to keep changing significantly in the 'seventies. This will be a result, partly, of developments all across the general transportation scene—developments that are sure to influence what railroads do in this decade.

In the past, railroads did much to shape the economic and social environment of our nation. The carrying capacity of freight cars, the speed of trains, the design of the once-important rail passenger service and the clearance diagrams of railroad bridges and tunnels dictated how the railroads would run and, in turn, how the country would grow. Today the entire changing environment more and more is shaping the railroads. Not only are competing modes challenging us, but other pressures are bearing heavily on the future of our operations. Thus our tasks stand to change as a direct result of what is happening throughout society.

On-time service is demanded

Transportation cost today is a critical factor in our intensively competitive economy, and the shipper is determinded to get the best possible service at lowest price. Today, in the face of the competition, we realize fully that the only way that we can protect our share of the business is to do a better job of moving this country's products than any other carrier can. This is a necessity we are facing squarely. Today's freight trains move at express speeds, in heavily powered trains. Their operations must be worked out so they have a minimum delay at terminals or along their routes. Their performance must be such as to guarantee the delivery of their contents on time—and on time means spotted and ready to unload.

What challenges does that suggest to you in your work? It does, of course, reinforce the necessity that I mentioned earlier—yards and tracks and bridges which are capable of handling today's equipment under today's operating conditions. And, it demands that the construction and maintenance work you are doing must be programmed so ingeniously that you do not delay the tremendously important schedules of these trains. You're not a highway builder who can lay down a detour and then let the traffic bump over it for several months while you build your road—or, better yet, select a new route and blissfully work on it while the traffic speeds by a mile away. You're not the dam builder who can set up a cofferdam and leave half the river open while he works on the other half.

No, you're required to bring this railroad up to the new standards that we need, with the consequent replacement of structures, and the realignment of tracks and yards, without disrupting the flow of traffic over its lines. This was a big order back in earlier days of railroading. With the faster pace of our operations, and with the increases in traffic, it becomes a greater task today. And do not forget the forecast that traffic may double by ten years hence. I am happy to say that you have responded to this challenge with ingenuity and resourcefulness, and the cooperation you get from your operating departments is a fine example of modern railroading.

Let us turn to another problem which is already upon us—and which will be with us from now on. This is the task that you are already engaged in, and will be giving increasing attention in the future, of engineering the railroad so that it can operate efficiently and compatibly within the physical environment which surrounds it. We are all face to face with the problem of growth of our great urban areas and all it entails. This growth will continue, and people will grow more sensitive to the intrusion on their way of life that growth in our in-

dustrial and transportation system may bring.

Propounds some questions

How, for instance, do you expand your yards to take care of increases in traffic, when the whole weight of the city is already pressing against railroad boundaries? How do you keep your traffic speeding from point to point as street after street is opened across your tracks, bringing added pressure for speed limits and complicated safety devices? How do you plan, engineer and install these devices and other complicated and expensive structures, and at the same time hold down the cost of your railroad operation so that you can stay competitive?

These are questions already being faced, but in addition there are future unknown areas of concern amid the hue and cry in the name of "ecology." For example, in California last June a proposition on the state ballot could have stopped trains, trucks and ships for approximately two years by requiring them to use fuel that is not available and for which there is little or no manufacturing capacity. Fortunately the voters realize that this was no solution to our air pollution problem and voted overwhelmingly against it. However, there will be similar proposals in other states, and undoubtedly we face stiffer regulations in the future on such concerns as noise levels and locomotive emissions, even though we know that railroads produce twice the ton-miles of freight while using half the fuel and causing less atmospheric pollution than trucks.

Exactly what problems will arise and what the solutions will be is unknown now, but most certaily there will be costs to be met. These costs will have a direct bearing on the profitability of your railroad, for such expenditures will bring in not one cent of revenue, and they will be competing with your own desirable maintenance and construction projects for available funds.

We intend to press ahead into every area of new technology which will help us to do our job better. In doing so, we know that we will, at the same time, be helping to solve some of the newly critical problems of the environment. Rather than a turning away from technology as some advocate, we must have a more imaginative and courageous use of it by business, by science and by government. Surely we are not going to have resources enough, jobs enough, housing enough or education enough to bring significant improvement to our society unless we *use* our technology with increasing wisdom and effectiveness.

In using it we must be prepared at all times to confer with the other disciplines in a *team* approach. Engineers must become more conscious of their responsibility to point out to management that the least costly, most efficient way to do a job may not always, in the end, be the most appropriate and lasting solution. And then those with the responsibility of management —business and political—must make the final decision.

The entrepreneurs who built our railroads were considered the giants of their century. The earlyday engineers of my company, fortunately for their day, were able to plan and lay down their track with a single-mindedness of purpose which would not be possible in our present complex environment. Today, just one intricate grade separation of railroad and highway may take as long to push through the various political, engineering and construction stages as it originally took to grade and lay 100 miles of track through a wilderness—and it may be about as costly too. On the other hand, our modern machines make light work of many tasks which for the pioneers were all but impossible. In attacking many of our engineering problems today we can even look to our computers to speed formerly tedious research to accomplish in only minutes, yet we also recognize that we face many human problems

which can never be programmed for the computer.

Should anticipate future needs

Coping with the new high levels of public expectation requires sensitivity to how people feel and respond, anticipation of what future needs may be, initiative in making modifications where necessary, and—above all—bridges of understanding between the feelings of sometimes-impatient humanity and the mechanisms of the practical, necessary organizational structure.

This is a tall order and neither engineering nor any other profession alone yet has what it takes to fill it completely, as far as I know. We have to work on it—while we try to steer away from the collision courses urged by some. Let us not lose sight of our obligations to our shareholder owners, as well as our duty toward the environment. We must develop solutions fair to all. The type of technological approach that put men on the moon while we earth-bound viewers participated through live telecasts can certainly be utilized and adapted to economically answer many of our problems.

In some cases, I should think, the needed technology already exists somewhere and our assignment is to find it and adopt it to our needs. Other technology must be developed by us to meet well defined considerations, and we should be using all avenues for developing it—research and development work on our own individual properties, through our common efforts in the Association of American Railroads, through cooperation with the Department of Transportation, in our relations with our suppliers, and through exchange of information with railroads of other nations.

Many of you gentlemen, every roadmaster and B&B supervisor, are the managers of a portion of your railroads' property. You play a very important role in all of those operational functions which are vital both to the present performance and the future success of your railroads. You have a large share of responsibility for what materials are purchased. You have responsibility for the proper upkeep of your tracks and structures. Daily, you must meet the challenges of balancing that maintenance with the transportation demand. Yet, while you are keeping today's railroad in shape you must constantly be thinking in terms of the changing needs of te future and planning to meet those needs. But the tasks which should be accomplished today and the good plans which should be moved along for the future won't be accomplished and won't be moved *unless you manage.*

Maintenance is unending job

What I am saying is something you know very well. But I am reminding you, because perhaps there are times you would rather not face up to it. In all of the responsibility I mentioned, your work as a manager is "never done." To an outsider who knows only that the railroads have been in the business of moving locomotives and cars over steel rails for well over a century and a quarter it might seem that a "laboratory" of 200,000 route miles of railroad which has been in existence that long most certainly has weathered all storms, met all challenges, established all standards and written all specifications. You and I understand why that is not the case. We understand that the maintenance job is unending and yet never quite the same, either—that we never achieve a routine that is so perfectly organized and so well oiled that it runs itself. And we understand that we can never relax against problems we have with today's equipment and which we know we also may have with the considerable amount of entirely new or widely modified equipment of the future.

And so, as you manage in these criti-

cal areas, there are some pretty sure bets for the future I can recommend that you keep in mind. First, there is going to be opportunity for our railroads to increase traffic by 40% in just five years and probably to double it in just the next 10 to 15 years, if we are only ready to handle it. We could spend some time developing that thought, but I trust that we realize how deeply significant it is for us. What may be more difficult for us, in the press of day-to-day work, is to remember to keep it in the fronts of our minds at all times—and I say to you that we must.

Secondly, costs are going to keep inching up, and revenues almost surely are going to keep lagging behind those increasing costs. So we have to look harder for the savings. If by running an outstanding maintenance operation, you can permit operations at increased speed or of heavier loadings, you will be making a tremendous contribution to relaxing this ongoing cost-price squeeze.

Thirdly, and as I mentioned, your maintenance job is never perfected, yet perfection must always be your goal. The assignment of transportation is rather simply stated in terms of its essential requirements. Moving things from here to there, safely and when expected, is the business in which we're all engaged. Although the execution of this assignment grows more complex in today's environment, that's what we're here for.

A fourth prediction we can make with some certainty is that government is going to impose additional safety standards, and that public standards for environmental controls also are sure to increase. These things are going to raise our costs—in terms of both materials and management. How much, no one can say at this time; nor can we be sure what part of the costs can be recovered. What we do know is that if we don't work diligently to set good standards for ourselves and do a good job of self-policing, then others will insist on doing it for us, and doing it more expensively. No one is better qualified than we ourselves to establish and maintain reasonable standards in these areas, and we want to do as much of this as possible for ourselves—not have it dictated to us. More and more inflexibly imposed standards—which might see government trying to regulate ever-more aspects of operations under the guise of safety—impede our ability to compete and cannot possibly accommodate the diverse climatic, geographic, traffic and operating conditions encountered in our industry.

Finally, the service requirements of our customers will escalate, not only in terms of greater speed and dependability but also in terms of equipment we will be expected to furnish. Car design will continue to be influenced by the shipper's need for reduced labor cost in loading and unloading, and by the railroads' need to reduce unit costs of handling shipments. These needs won't always be compatible, of course.

Research and development for customer service as well as for our own more efficient operations therefore will continue to be absolutely vital. As we pursue these twin objectives we need to have firmly in mind that the pace of competition in this entire field guarantees the obsolescence of some of our equipment and some of our methods.

Need help of all technology

And, by the way, it also virtually guarantees the obsolescence of a conventional engineering education within a decade or so. We all have to keep learning and searching. We can no more say that we already know everything we need to know to do our jobs than we can say that we already have built the ultimate railroad. We labor in an old and honorable but still evolving industry. Just ahead are many new opportunities for us to develop railroad equipment and methods which will mesh with and promote coordination

between all modes of transportation, for a combination of modes is certainly the needed transportation of the future. We shall gain the reward, therefore, if we press ahead into every possible area of new technology which will help us to do that job better.

Having mentioned some of the challenges, what further can I briefly suggest in closing that will help us to improve our performance? I'd like to speak of just three of the things which I think are important:

First, we must stay keenly aware of our interdependency, pursuing our group interest as we do our self-interest, and looking after those effective communications which are so imperative today.

Secondly, we must step up our emphasis on quality control on everything we are using to do the job today.

Thirdly, to get ready for the big job tomorrow, we must vigorously encourage an integrated industry-union-supplier-government approach to research and innovation, nationally and internationally.

On the subject of the first of these items, we recognize that our situations vary from region to region and from road to road. Yet in the handling of a great share of our traffic we are so interdependent as to require that we be about as concerned with another's problems as we are with our own. If you move a transcontinental shipment over your railroad exceptionally well but I then take it and move it over mine very poorly, it is rather obvious that all that really concerns the owner of that shipment—our mutual customer —is that, together, we delivered it late or in bad shape. Or if a defective car off your railroad gets into a train on my railroad and goes undetected just long enough to cause a major service disruption, then every railroad and every shipper with cars in that train will pay the penalty.

Given such conditions, it is imperative that we work together for the solution of all of our problems—construction, maintenance, operating, legal, political—and that we share our advancements. I am encouraged by the way we have been doing that in recent years, and I am confident that we are stepping up the pace of our cooperation at this moment. And I think that a very significant byproduct is the fact that as we do so we are showing the public why it has a real stake in seeing that we eventually get the regulatory relief which is so long overdue.

Demands upon plant become greater

The need for improved quality control—the second of my three suggestions—is extremely important at this moment. The time is at hand really to put the pressure on ourselves, our suppliers and our fellow railroads to build greater reliability into original designs and then to police continually to maintain it. Nearly every day one of us has bitter experience with a major interruption to traffic because of the failure of one small component to perform as expected. As we handle heavier loads at higher speeds in a wider variety or equipment, the demands upon our plant became greater all the time. We must insist on better reliability all across the board. And each one of us must look beyond the individual components in which he is primarily interested and study how they affect related parts and, beyond that, how they affect operations as a whole.

On the third point, I would reemphasize that we must do much more to pool the great creative talents on our railroads and among our suppliers and potential suppliers, and also to involve government resources, to line up the necessary people and money to support well-directed, industry-wide research which will truly be in the national interest.

We have to demonstrate solid progress as managers on these three points if we are to expect the public, through the Congress and the adminis-

tration, to give us the help which we need and deserve on the other problems we have. I believe that we can.

Gentlemen, you have my compliments on the fine job you are doing today, and my confidence that you will measure up to the splendid opportunities which are ours for tomorrow.

President Fuller: Mr. Biaggini, please accept our sincere thanks for addressing us today. Your words of confidence and optimism as well as the warnings of things to come in the future will undoubtedly provoke many hours of study and thought by all of us.

I will now turn the microphone back to President Gunderson.

President Gunderson: Within our roadmaster's organization we have a rather large number of responsibilities among relatively few people. But this isn't unusual to you people who are having the same thing happen to you on your own properties. At this time I would like to excuse a few of the people on my left, particularly Rod Dennis. Rod is chairman of our registration and probably is itching to get out there so he can see what is happening and help. Any of the others who feel they must join with Rod at this time, feel free to leave. Tom extends that same invitation to people on my right.

Introduction of C. S. Wolff

Our next speaker is a technical advisor for industry with the Occupational Safety and Health Administration. He is a graduate of the University of Illinois with a Bachelor of Science Degree in Civil Engineering. He has served as traffic engineer of the Cook County Highway Department, safety engineer with the Hartford Accident and Indemnity Company, assistant managing director of the American Society of Safety Engineers, senior engineer with the National Safety Council, and safety engineer with the U. S. Department of Labor. He is Certified by the Board of Certified Safety Professionals.

Speaking on the subject, "Update on OSHA," it is now my pleasure to introduce Mr. Charles S. Wolff, (Applause)

Update on OSHA

By Charles S. Wolff
Technical Advisor, Industry
Occupational Safety & Health Information

Thank you very much, President Fuller and President Gunderson, honored guests, ladies and gentlemen:

When I talked to Mr. Dick about this program and what would be most beneficial to you, I think he put it very succinctly in a letter which he wrote, and he has repeated since then. He says, "They want to know precisely where they stand with respect to the Safety and Health Administration regulations and the law in general." So my objective this mornnig will be to try and tell you that and let me say that if any of you have any questions which I don't deal with in the course of the presentation, I will be happy to hang around afterwards as long as you like

to deal with them on a personal basis or any other way that is going to be beneficial to you. You are the taxpayer and I am the employee and my job today is to set you straight as far as humanly possible and that's what I will try to do.

Just coincidentally, this week-end I went with a couple of friends of mine on a little bachelor jaunt and we included in our itinerary the Museum of Transport in the St. Louis area. I spent practically a whole day crawling over, around, under, on top of some of those old 4-8- 8-4's and 0-10's and everything because I do have an interest in that sort of thing. It was most enjoyable and as railroaders if you haven't been there and you have the opportunity, I would say to take advantage of it. I even saw a fireless locomotive, which is something I never even dreamed existed, but they have one there, believe me.

So much for that. Now let's get to the business at hand, the Safety and Health Act of 1970.

It was signed by the President in 1970. It became effective on April 28, 1971. We went through a familiarizaton period that lasted until August 28th of 1971. We began a limited enforcement in August of 1971, and in February of 1972 for all intents and purposes the law was fully effective and being enforced.

Purpose of Health & Safety Act

Now what was the purpose of the law? The law was passed to assure every working man and woman in the United States a safe and healthful working place. And also, and I think probably a key to one of the reasons why the law did pass was the second part of its purpose, which was to conserve our human resources. As you all know, we are very much concerned today about ecology and this kind of thing, and that includes the conservation of our human resources. So it seems at that particular time that law's time had arrived and it passed.

It applies to all employment in a business affecting commerce and that is the broadest possible interpretation that the Congress could put on the law. And keep in mind that the Congress at any given time may react to situations that exist at that time and they probably look at it in a sense that the mechanical problems that are created may be resolved at a later date. I have the feeling this is actually what is now happening. But the broadest interpretation of the law covers about 4.1 million establishments and about 57 million people.

Now there are exceptions to the law and I think this is the point where you will be most interested and probably want to hang onto the word here. State and federal employees are not covered by the law. Now you may well ask, "How come the federal people aren't covered? You know, what's good for the goose is good for the gander, and so forth." It's a reasonable way to look at it and the response there is that we are covered under a separate executive order issued by the President. Federal agency managers must maintain the same kind of environment for their people that industrial people do.

State employees or employees of other governmental bodies are not covered at the present time, but they will be in all probability as approved state plans come into effect. But that still doesn't really speak to this audience.

Now I think what you want to know is simply this. There is no coverage where a federal agency other than the Department of Labor has an authority and is exercising that authority. And the way I have it written here, "Statutory authority to prescribe or enforce occupational safety and health standards or regulations."

If there is an authority under the federal law but it has not been put into effect, that is to say, there may be no regulations applicable or the authority simply may not be enforced,

then there certainly is the possibility that the Safety and Health Administration will come into the picture. That was the intent of Congress as we read it.

Now if there is no authority and an authority subsequently comes into being, then we would simply have to look at the intent of Congress and try to figure out what did they mean and what were they trying to accomplish?

Interface of authority

Now when we think of these exceptions it is obvious that at some point there is an interface, if you will permit me the use of a little bit of governmentese, an interface of authority. And I think that is probably the situation that we have in hand at the present time as relates to the Department of Labor and the Federal Railroad Administration.

Now it has been suggested that the OSHA, (Occupational Safety and Health Administration), we're great for acronyms in the government. You never get away from it. Jurisdiction extends to the point where you exit from your office and enter upon your operating areas. I personally feel that is a pretty good idea and I hope that is the way it will go. And I have several reasons for saying that.

First of all, we have plenty to do in industry and we have nationally 500 compliance people to do it. Now in my own case, as has been indicated earlier, I have been in industrial safety for more than 20 years, but if I tried to go out into a railroad operation I would feel like a fish out of water and I will be very honest with you. And believe me, when it comes to seniority of experience in our agency, I am pretty well up near the top, I would want nothing to do with any operations out on the right-of-way or in the roundhouse or anything like that.

Now I probably would feel a certain amount of competence in the maintenance shop because I am familiar with machinery, with lathes, with material handling equipment and related processes. But generally speaking it is my feeling that this idea of covering the office and going no further is a good one. It is true that this whole problem is a subject of continuing discussion in Washington. We have the same situation with respect to the Atomic Energy Commission, with respect to the Department of Agriculture, with respect to the aviation authority—I can't remember that one right off hand.

So, after talking to our regional administrator and talking to one of our area directors and talking to the Federal Railroad Administration people here in Chicago, I think that some of the good news that Mr. Biaggini referred to would be characterized if I say, as far as I can see, the profile of OSHA with respect to railroads is relatively low. We don't have you very high on our priority list. And I would like to say that in my own experience I know that the interest of railroads in safety goes back many years.

I know, for example, that a man named Richards with the Chicago & North Western Railroad, way back 50 years ago in Milwaukee, was one of the founders and guiding lights of the National Safety Council. So I don't think our posture is, "Well, O.K., now we're going to come in there and we're really going to show you because you have not been doing a job." We know that a job has been done.

I have asociated for many years with the fellows on the Railroad Section with the National Safety Council and again know there is a very powerful consciousness in the railroad industry and there really doesn't seem to be a heck of a lot of need for OSHA to stick our nose in there anywhere beyond the office door.

Priorities of OSHA attention

Now let me back that up by giving you what our priorities are at the present time.

Approximately 10% of our time will be given over to the investigation of fatalities and catastrophies, and essentially that is an industrial type thing. I don't think we have been involved at all, I am sure we have not been involved at all in Region 5 with any kind of mishap that has occurred on the railroad right-of-way. We have been involved in construction accidents and fireworks explosions and that kind of thing. But I can't find any instances where we have had any dealings directly with the railroads. Now we may have on an industrial siding or something like that, but even that has not been a big thng.

O. K., first priorities is catastrophies and fatalities. The second priority is the investigation of valid complaints.

Now recognizing that there is a possibility that we might have a complaint from a railroad person, there has been set up a procedure, and I will get to that in just a minute. First, let me deal with the rest of the priorities, and I think you can kind of fit yourselves into our priority system. And this will tend to reinforce what I have already said about low priorities.

We have a target industry program. There are five industries involved and we are concentrating on them. The reason being that their accident records are not quite as good as they should be. None of them is in any way related to your operation—wood products, roofing and sheet metal, meat packing, miscellaneous transportation equipment, which refers to the manufacturer of such things as mobile homes, trailers, and that sort of thing, and longshoring. All of these have injury frequency rates upwards of thirty. Longshoring is in the vicinity of sixty-five. And it is because of that, that they selected those industries for emphasis.

On the same level you might say with the target industries is the target health hazard program and this is something that conceivably in the long range you might want to think about, not so much from the standpoint of our enforcement efforts but from the standpoint of what is important to you.

Now the target health hazard items are silica, lead, carbon monoxide, asbestos, and cotton dust. In each instance it has been found that people exposed to these materials for long periods of time do suffer some very definite ill effects, but again nothing that relates to railroads in any direct sort of way.

Now our third priority is simply general inspections, to which we should be directing about a quarter of our time. Those inspections are made across the board in industry, the only criteria being size, geographical location, and type of operations. Obviously some kinds of industrial effort are more hazardous than others. So that's why we're going there. Again, I don't see anything at all about investigating things that happen on the railroads.

There is one thing that Mr. Biaggini said that I would certainly want to agree with wholeheartedly and most sincerely and that was his comment relative to standards and the development of standards and this idea of police yourself, and that is exactly what the Safety and Health Administration has been saying, Secretary George C. Guenther places the highest priority on voluntary compliance because you know doggoned well it is a matter of simple arithmetic with 500 compliance officers nationally we cannot do the job in over four million establishments.

I think one of the labor organizations has pointed out, and I am not going to vouch for the arithmetic, but they said something like 200 years for our present force to do the job. And, you know, the idea was we need more people.

You can see what I'm talking about here. If we can engender the idea of voluntary compliance, then the job will be done and the objective of the Agency, safety and health in the work

place will be accomplished. That is really what we are trying to do. We are not going to try to go out there and find people with egg on their face and penalize them because we get some kind of perverse enjoyment out of it.

I would say, involve yourself in the constitution of standards and make it possible for people in your organization to do it, and involve yourself in this idea of voluntary compliance because Heaven knows you can do a far better job than anybody from the outside who doesn't know anything at all in depth about railroad operations. I would not expect someone from a railroad to come in and do a good job of inspection in a company that manufactured refrigerators, and it works both ways.

Handling of complaints for railroads

I wanted to talk a little bit about complaints because at the present time there is an interim agreement between the Federal Railroad Administration and the Secretary of Labor when and if a complaint comes to us from a railroad employee. This interim agreement is dated June 7, 1972, and as far as I can determine as of last week, Thursday, or Wednesday, it was still in effect.

If you will permit me I will read this because I am not that familiar with this procedure. "If a complaint is received by OSHA on the railroad industry the following will happen:

"The local line people forward the complaint to the OSHA solicitor. He contacts the FRA Council." Now why they have a Council and we have a solicitor, I just don't know, but that's some more governmentese, you know. Why we can't have a councillor and they can't have a solicitor is beyond me. "The OSHA solicitor contacts the FRA Council within five working days. They will jointly determine which has authority to remedy the conditions complained of."

I checked on a few of them that have been forwarded to Washington and I think the five working day limit has been exceeded.

"The agency having authority will make inspection and take enforcement action. If a variety of conditions are involved," that is to say, I can conceive of this where you might be talking about some things which are very much in the railroad area and some things which are very much in the industrial area and then we will make a joint investigation. And that would be lots of fun, I'm sure.

"Alleged imminent danger, the top priority agency will pursue this question."

Perhaps I ought to talk a wee bit about this question of imminent danger. We spend a lot of time on it. There is a lot of verbiage in the law that deals with it but it's not something that happens every day. Imminent danger is defined as a situation where there is immediate and serious exposure to death which could happen right now. If you had one of those old steam engines down there at the Museum that I was looking at and you had the old needle sitting up on 400 pounds and the steam was coming out all over the place, this would be characterized as imminent danger because that thing could blow up any minute. Those situations don't occur every day, every week, or every month (because obviously the man who is running the enterprise has a greater stake in eliminating it than the fellow who works there.)

Any way, if there is an imminent danger situation encountered on the railroad the top priority agency will pursue it. Of course, if we're waiting for those lawyers to come through with a decision I guess we'll all be on the moon before we get that one resolved.

"Any jurisdictional problems that arise in connection with this will be handled in Washington." And thank Heavens for that. I'm just a regional guy and I don't want any part of that monkeyshines.

Let me proceed from there. I guess

I told you that in recent months there have been no joint inspections in Region 5. Now Region 5 is our area—Minnesota, Wisconsin, Illinois, Indiana, Michigan, and Ohio. In a very rough sort of way it corresponds with the Federal Railroad Administration area. There are some slight differences. But, no matter, we have had no joint inspections.

Most complaints concern health

Now there is one possibility that may occur and I think there is a certain amount of logic here that supports this. Railroad people may see OSHA personnel on occasion in a supportive capacity to the FRA people. And I am talking in terms of perhaps health problems. Because in our experience in those complaints on industry we have received, fully 60% of the complaints dealt with health problems. Now that is a disappointment to an old safety type like me. It should be the other way. But that's the fact of the matter. When I am talking about health problems I am talking about things like vapor, gases, fumes, mists, noise, dust, et cetera. So that the industrial hygiene aspect of the thing turns out to be more significant and important than the older, more traditional safety things.

So you may see our people in a supportive capacity. And I think that makes a certain amout of sense. The FRA people may be talking to the EPA. Here we go again with the acronyms — the Environmental Protection People.

Now let me tell you just a few things about what we have done as far as industry is concerned. I don't want to belabor you with statistics, but I think it serves one purpose. I think it again substantiates what our posture is with respect to the railroads and more importantly, what our posture is to industry, because you know darned well if we are approaching industry in a certain way, then if we ever do approach the railroads it will be with the same kind of philosophy.

We have made about 32,000 inspections in the year, in the fiscal '72. We found about 25% of the people were completely in compliance. That's pretty good when you stop and think some of the regulations we are enforcing may be a little on the Mickey Mouse side for the time being. 40% of the inspections made resulted in penalties being proposed. That's pretty good, also. That means in 60% of the cases there were no violations or the violations were of such nature they didn't warrant any kind of penalty being proposed. Only 4% of the violations were deemed serious. And that is where there is a substantial probability that immediate serious injury or death will result. We received 4,900 complaints and, as I indicated, about 60% of those are in the health areas.

Now, again, to go back to standards. The Department of Labor moved very quickly for maximum coverage when the law was passed. They set up task forces and they worked day and night and there were several nervous breakdowns, so that it was a very, very trying time for these people. But they did produce an initial standards package one month from the time that the law was passed.

Will improve standards

Now we admit, and I indicated earlier, we have a few Mickey Mouse items in there. We admit this is true and at the present time there is a very searching, sincere, conscientious effort in Washington to take those things out of the standards because they don't mean anything as far as safety and health are concerned. We had such things as the requirement that all toilet seats be open front types, you know. And we had one in there that forbade the use of ice in drinking water. I was panic sticken because all the cocktail lounges that I patronize, they will put ice in there if you say, "On the rocks."

Incidentally, that one is a good example of one that actually goes back to the days when they cut ice on the lakes. You know, the bears in the winter weren't too careful about what they did out there so they wanted to keep that sort of thing from getting into the drinking water. Well, it is recognized now that things have changed, so they are taking that out.

Another one we had was the color of aisle lines in factories. You know the law said they have got to be white and the guy called me and, he said, "What difference does it make?" And as far as safety and health are concerned it doesn't make a bit of difference. The important thing is you designate an aisle and this is the storage space and here you put the fire extinguisher, and that sort of thing. Whether you do it in lavender or purple, it's not significant.

What I am saying is that there is, thank heavens, a note of reasonableness and logic that exists in Washington at the very highest level and as a professional in safety I am very happy that is the way it has gone.

Now I'm going to go about two minutes more because I said 30 minutes and I'm going to quit, and then I will answer questions if there are any.

What can you do? Now I'm talking as if I was talking to an industrial group, let's put it that way, and just ignoring for the moment I don't believe we are going to have much contact.

Get active on standards, analyze standards, and provide input because these fellows in Washington cannot be experts on everything all the time. So if there is something in the railroad area standards that is important to you and significant, for Heaven's sakes, let them know. Pass it on to them. Insist on professional safety people wherever you can. And I think probably the most important one of all is, subject yourself to a rigorous self-inspection. Don't let some other guy come in and do it. You can do the best job and by all means it is much better that way.

OSHA operations not punitive

Finally, whatever you may have heard about OSHA, and, boy, there has been a lot of stuff around, I want to re-emphasize that it is not a punitive operation. We are not splitting hairs. We have not put anybody out of business. There have been stories going around about that and that is not true We don't know of anyone who has been put out of business.

We hope we will be given a consultative capacity. In other words, we will get away from this routine of going into a man's place of business, and if we go in and have to cite him. We will be able to go in and do it in a consultative fashion. It looks very much like that is going to be the way it goes. And again, as a safety type, I'm happy about that.

I should mention just briefly state plans. I'm not going to go into that in detail but the idea is that in this administration, meaning the present national administration, the thought is that every thing should be returned to the people, all the jurisdictions and all the enforcement activities should be returned to the states or even to the cities and counties, if possible. That is happening with the Safety & Health Law. By the end of '72 approximately 10 states will be enforcing our standards. By the nend of '73 approximately 15 more will be enforcing our standards. We will back off and we will do nothing more than perform an audit function.

The only state that I know of that has been involved in any kind of off-track railroad situations is the State of Wisconsin. And that's all I know. I don't know anything about their law, but they are one that has been into this area a little more than others.

One other thing, record keeping is an important part of the OSHA program. Railroads at the present time do not have to keep records on our forms and go through our routine. I would hope that situation would stay as it is.

However, I would suggest that those people responsible for keeping safety and health records at least familiarize themselves with the OSHA forms. And that can be done by calling one of your local offices and asking for the record-keeping forms and the record-keeping booklets. That is only a suggestion and certainly not an admonition.

I think I've gone just about 30 minutes and I have tried to deal with those things I thought would be meaningful to you. As I said before, I'll hang around and talk to any of you on a personal basis, or, if our time frame permits I'll answer any questions right here. If not, thank you very much. It has been a pleasure being with you. (Applause)

President Gunderson: Thank you very much, Mr. Wolff.

I think many of us in the railroad industry have been in positions very much like those facing the potential bride groom when he first met his potential in-laws. Both concerned about resolutions of mutual problems, some that were due to either commission or omission, and each very much interested in what was going to happen next.

Now most of us feel much more at ease with each other today, particularly as the kinfolk on both sides have broadened their basic communications. I feel very strongly that a major share of this credit is due to people like yourself, Mr. Wolff, and the gentlemen who will be speaking to us next, coming before groups like ours, discussing mutual problems in open forum. These are the ways that we each become better acquainted with each other and ultimately accomplish our mutual end.

Mr. Wolff indicated that he will be available after the session this morning to discuss any problems that you may have, any questions you may have. And again, Mr. Wolff, we thank you very sincerely for being with us this morning.

I return the podium now to Mr. Fuller.

Introduction of J. E. Rourke

President Fuller: Our next speaker this morning is Mr. J. E. Rourke, Director, Safety Task Force of the Federal Railway Administration.

Mr. Rourke graduated from the School of Engineering, Tufts College, and went to work for the Boston & Maine Railroad in the Engineering Department.

Within a few years he transferred to the Operating Department as assistant trainmaster, and thereafter a series of promotions within the Operating Department until he was named assistant to the vice president, his position at the time he joined the FRA.

Following his address, Mr. Rourke will answer questions from the floor. So if any of you have any questions about any of the track standards, here is a chance to get a direct answer from Mr. Rourke. Mr. Rourke.

Modifications to FRA Track Safety Standards

By John E. Rourke

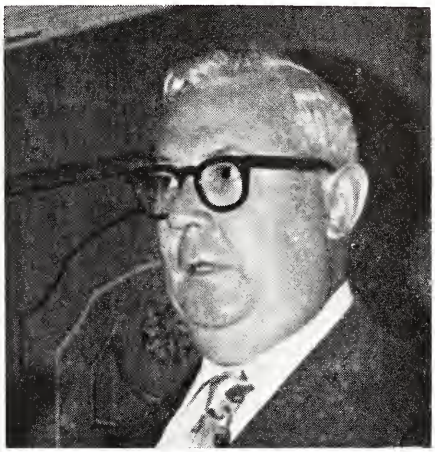
Director, Safety Act Task Force, FRA

Mr. Fuller, Mr. Gunderson, members and guests: Good morning!

As an aside, I would like to mention that your program is heavily weighted with government this morning. I think that's good. I think the dialogue that we have been able to bring about between you people and FRA, and also between OSHA and you people, can only be beneficial to all of us. So, I congratulate you on that.

I am delighted to be here with you today to talk about the FRA track standards and the amendments which have just been published.

I will try to faithfully transmit the thinking of the Federal Railroad Administrator, John W. Ingram, who wanted to be with you today. However, he was asked to lead a delegation of ten people as a part of the Cultural Exchange program with the USSR—so he couldn't be here with you today.



John E. Rourke

Last October 20, Secretary of Transportation John A. Volpe announced issuance of the first Federal minimum track safety standards for the Nation's railroads in accordance with the regulatory powers granted him under the Railroad Safety Act of 1970. This is one of the major pieces of legislation President Nixon had sought and obtained from the Congress, which is a part of the most important railroad legislation ever passed during any Administration in our country's history.

With the enactment of the Railroad Safety Act of 1970, the Department of Transportation took over responsibility for *all* railroad safety, including track and roadbed, equipment and operating standards.

When the Federal Railroad Administration issued the first set of rules governing track, Secretary Volpe said, "I emphasize that these are *initial* standards. As we develop greater knowledge from our safety research program and from experience in actual operation, they may be upgraded, relaxed or modified when in the public interest and consistent with safety."

Points to safety research project

Federal Railroad Administrator John W. Ingram is pressing ahead with several safety research projects, notably the installation of a test track in Kansas on the mainline of the Santa Fe Railroad over which about 55 million gross tons are moved every year. Completion is nearing on an 8,000-foot test section which includes several experimental track structures, including con-

crete ties with varying spacing, slag track, stabilized ballast, as well as conventional track for comparison.

We hope funds will become available to expand both the length of the track and the variety of the experiments, for this is one area of rail technology that stands to benefit greatly from further research. The analytical problems involving the random distribution of vertical, lateral and longitudinal stresses, superimposed by a moving train on the static stresses present in a track, are known but certainly not fully understood. The solution of such technological problems is further affected by the fact that the elasticity of the track of course varies according to the composition of the support medium.

We also need a better understanding of the interaction between the steel rails and the steel wheels on rolling stock. Toward this goal, a rail dynamics laboratory is now under construction at the FRA's High Speed Ground Test Center in Pueblo, Colorado. In this laboratory, we will be able to simulate the interface between rail and wheel, and test new approaches to old problems by nondestructive testing devices and techniques.

In addition, we are building a 20-mile loop of conventional railroad trackage on which we will be able to test train and rail interface under controlled conditions and observe the effect of track imperfections on train operation.

All of these tests and experiments will provide the industry with new knowledge about track and they will provide FRA with information to insure that its minimum track safety standards are in fact just that.

Amendments now in Federal Register

Amendments to the track safety standards proposed by the FRA following lengthy discussions with the industry, labor, equipment suppliers and others involved in and concerned with operating railroads safely appeared in the Federal Register on Saturday, September .

But before I describe these proposed changes, let me briefly review our rulemaking procedures under the Railroad Safety Act.

Standards are regulations issued by the FRA under authority delegated by the Secretary of Transportation. They are not laws inasmuch as laws can be changed only by Congressional action.

The first time the public sees a draft of a standard is in a notice published in the Federal Register. That may be an "advance notice of proposed rulemaking" or a "notice of proposed rulemaking" depending on the complexity of the standard among other things. Comments are invited, and a hearing may be held. When the period for comments is closed, FRA considers all the information it has received and publishes the standard as a regulation. But this regulation is not cast in concrete. It can be and usually is, modified as experience and further information is generated.

It is important to understand that standards are not intended to limit development of new methods or products. FRA welcomes progress and innovation in the development of better railroad track and equipment, and the standards are going to be changing continually to encourage technological advancement within the industry.

Since the first track standards were issued, the FRA has been in contact with different segments of the railroad industry to discuss problems which may arise in complying with the new standards. In the main, the amendments proposed by this notice stem from these discussions with industry and from the FRA's own continuing study of the problems involved.

Some of the proposals are for purposes of clarification and would not ordinarily require notice and public participation. However, because in other cases substantive changes are involved, it has been decided to offer all of the proposals for comment in this notice.

Most are effective October 16, 1972

Most of the proposals concern that portion of the Track Safety Standards which will become effective for the bulk of the Nation's raliroad system on October 16, 1972. The FRA anticipates completing the rule-making proceeding in time for those proposals which are adopted to also become effective on that date. In this way, railroads would not become subject to a set of rules on October 16 for which proposed amendments are pending. Two of the proposals affect other sections of the standards which will not become effective until October 16, 1973. Final action on these two amendments could be postponed, if necessary, to enable the issuance of a final rule on the other proposed amendments before October 16, 1972.

The most significant revision would affect train speeds. The FRA is proposing an amendment to the standards based in part on a petition filed by AMTRAK. This amendment would establish higher speed limits for passenger trains operating over classes 1 through 5 track. There would be no increase in the present maximum speed of 110 mph over class 6 track.

Under the existing rule there is no distinction between speed limits for passenger trains and freight trains over any class of track. These speed limits will result in an unnecessary reduction in present minimum running times for some intercity passenger trains.

We believe that increased speeds for passenger trains are justified by a number of factors. First, contrasted with freight cars, trucks for passenger cars are designed with greater vertical spring deflection, giving lower natural frequencies of vibration; greater distance between axles, adding stability when rounding curves; greater maximum permissible tread thickness on wheels, reducing the likelihood of wheel rim fracture.

Secondly, passenger cars are almost all equipped with the type "H" interlock coupler which reduces the tendency to jackknife in the event of a derailment.

In short, the FRA believes that passenger trains can move faster than freight trains over classes 1 through 5 track, without a decrease in safety.

Other proposed amendments deal with measurements of track while not under load; marking of maximum and minimum points in the elevation transition on each curve in classes 4-6 track; the requirements for minimum number of nondefectvie ties under a joint; the requirements governing maximum operating speeds over rails with defects; the minimum number of track spikes per rail per tie; fastenings in turnouts and track crossings; methods of track inspection; yearly inspection requirement for new rail; and, certain record keeping requirements.

We invite all who are interested to participate in making these proposed amendments by submitting written data, views, or comments. Communications received before September 30, 1972 will be considered by the Federal Railroad Administrator before final action is taken on the proposed amendments. Comments received after that date will be considered so far as practicable.

To insure that all interested people have an opportunity for oral presentation, the FRA will conduct a public hearing at 10:00 a.m. on September 22, 1972, in Washington.

Equipment standards in offing

As many of you know, a draft of equipment standards will be published shortly. They, too, are designed to prevent some of the serious derailments caused by such things as broken wheels and burned-off journals through insistence on better maintenance and inspection.

Another rapidly growing cause of all railroad accidents is human failure. Such accidents have risen from about twenty-seven percent in 1970 to over

forty-three percent in the last reportable quarter—a dramatic increase.

What are we doing about it? In Cambridge, Massachusetts, there is an organization that the Department of Transportation took over from NASA, the Transportation Systems Center. We feel they have the capabilities in their human factors branch to look deeply and critically at our railroad human factors problem and that within the foreseeable future we will be getting some answers.

But now, let me give what answers I can to the questions I know you want to ask about the proposed modifications to the track standards.

Now I know we are on short time and I presume one or two of you might have a question on the proposed amendments. If I can't answer it now I'll find an answer later. But I see a good looking gentleman sitting near the back named Bill Paxton and he's going to give me an assist as it will become necessary. I've been up here before and been shot at. I'm not bashful.

H. W. Williamson (Southern Pacific): One question, Jack, will there be any definition of what constitutes passenger equipment? Conceivably you could get freight equipment in passenger train service. How will that affect it? Has any thought been given to that?

Mr. Rourke: Yes, quite a bit of thought has been given to it, Harry. As you know, with these notices of proposed rule making we are really trying to accomplish two things and I think the more important of the two is to put something out to you people to educate us. As I told a group a couple of weeks ago, that's how I get my smarts. But, no, we have no definition at this time.

Certificate of inspectors

Mr. Brown: Jack, have any of these states yet been approved for administering the track standards within the states?

Mr. Rourke: None have been certified yet. Bill, do you want to bring these people up to date on the state certification program? Grab a "mike" up front here. I told you I'd put you to work.

Mr. Paxton: I will make a few very brief remarks about state certification. Many of you were at the last AREA convention in which we had an opportunity to discuss the status of state certification at that time. There really hasn't been any dramatic change since the early part of this year. We do hope to present in the very near future a public notice on minimum qualifications for track inspectors. This will be very beneficial for the states who have proposed certification. After that has been issued we will be in a position to evaluate the information which the various states have submitted to us. And incidentally, there are 26 now who have indicated a desire to participate under Section 206 of the Act. That's about the status now.

Has new Rail Defect chart

Mr. Rourke: Thanks, Bill. Bill, the standards were established September 9th. I understand there was an error in the Rail Defect Chart. That has been republished as of this last Friday, is that correct?

Mr. Paxton: That's what I understand.

Mr. Rourke: Was it going to be simply the chart or a reissue of the standards?

Mr. Paxton: Just the corrections to the chart.

Mr. Rourke: Thank you. You want to watch that, gentlemen, if you do pick up a Federal Register copy, that you get also the amendment published last Friday which corrects some typographical errors in the rail defect remedial action chart.

Mr. E. Franzen (Missouri Pacific): Jack, I understand that a request has been filed by AAR requesting that the hearing be postponed until after the deadline for comments on September

30. Is there any indication of what reduction this will get and if it will be extended or delayed?

Mr. Rourke: I have a verbal notice from AAR. They have requested a postponement of the hearing. I quite frankly think this request will be granted and that a new hearing date will be October 6.

Procedure of inspections

Member: Jack, what is the mechanics of your office notifying a railroad as to the inspection when they do become effective, and assuming you do not grant an extension of time October 16 of this year? How will we be contacted, by whom, and how do we respond? I understand from your articles you do not have a staff that will permit on-line inspection, but that you will draw from the railroad's own inspection report. Will you give us some kind of indication as to just what this will amount to?

Mr. Rourke: Yes, I can. I could bring Bill up here again and talk about the track inspection manual that we have been trying to prepare for quite a while. I could also mention to Mr. Wolff that the Department of Labor has been much more successful in the hiring of inspectors that FRA has under the authority of our new Act. They have five hundred and we have four. I don't think we're going to saturate you with inspectors.

Basically the inspectors are going to be monitoring your own inspections. No one is going to show up on your property except in the case of serious disruption in service, thank you, without notifying you in advance, telling you what he is looking for, and so forth and so on. The days of harassment, I'm sure are way in the background.

Now as far as a specific program is concerned, we are not ready to issue that as yet. It has not been approved. Basically the philosophy is to work with the carrier to help him maintain better track.

Hearing no further questions, I want to thank you sincerely for the opportunity to come up here and continue the dialogue that we have pleasantly carried on over the past several months, to invite you to call at any time when you have questions. Don't let them boil and bubble. Talk to us, talk to your government. You will find us very receptive because, after all, it's your government. Thank you very much. (Applause)

President Fuller: Mr. Rourke, please accept our thanks for coming here and addressing us today, and also thanks to Bill Paxton for assisting.

This concludes the first Joint Session of our Cenvention. This afternoon the Roadmasters' will convene at 1:30 here in this room. The B. & B. people will meet at 1:30 in the Beverly Room.

As information, the registration on Sunday was 159. This morning, to eleven A. M., 294. That is a total of 453. And I think it is 80 ladies present.

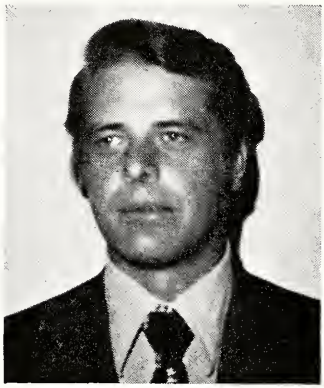
This session is now adjourned.

. . . Recessed at 1:32 A. M. . .

Cast-In-Drilled-Hole Concrete Piling

Committee Report

COMMITTEE—K. L. Wammel, *Chairman*, asst.b.&b.supvr., S.P., San Antonio, Tex.; R. J. Becker, *Vice Chairman*, reg.mgr., Lee Turzillo Con., Omaha, Nebr.; W. E. Brakensiek, asst.br.engr., M.P., St. Louis, Mo.; N. D. Bryant, asst.br.engr., S.L.-S.F., Springfield, Mo.; C. C. Compton, cons.supvr., S.L.-S.F., Springfield, Mo.; E. J. Dawson, asst.cons.supvr., S.L.-S.F., Springfield, Mo.; R. E. Frame, dist.engr., S.P., San Francisco, Calif.; W. H. Rankin, sr.struc.engr., S.L.-S.F., Springfield, Mo.; and A. B. Wang, b.& b.supvr., L.& N., Lafayette, Ind.



K. L. Wammel

Cast-in-drilled-hole concrete piling have been used extensively in the design of building, highway and railroad structures. In recent years, the use of this technique of pier and bent construction has increased substantially in the railroad industry. It is the purpose of this committee report to consider the factors involved in selecting and constructing concrete piling for bent and pier designs.

Advantages of cast-in-drilled-hole concrete piling

There are several factors which make cast-in-drilled-hole concrete piling advantageous to railroad construction. The drilled shaft provides a fast, easy and economical founding procedure, especially when the desired soil stratum is too deep for open-trench excavation or when the overburden would require timber or steel retaining walls to permit excavation. The overburden could consist of a soil such as a dense sand that would prohibit driving piles without jetting them to the required penetration. This, of course, is slow and increases the cost, making it impractical.

Many of the same advantages of conventional concrete-filled pipe piles are noted in the use of cast-in-drilled-hole concrete piles. They are as follows:

(1) The required size of the pile car be adjusted to the various design conditions. Although it is more practical for company owned equipment and design to have only a few standard sizes, most private drilling contractors have a wide selection of bit types and sizes to meet extreme cases.

(2) Concrete piles are relatively fire resistant and maintenance free. This proves very useful in high fire risk areas and inaccessible locations.

(3) The pile shafts may be inspected during all phases of construction, thereby insuring placement and compliance with the design requirements.

(4) Concrete piles and cap connections are easily made. The caps can be precast, poured in place or steel.

Unlike pipe or H-piling, drilled shafts can be drilled to the desired elevation thereby relieving the fear of pile end damage, premature refusal or a soil bulb at end of pile. The drilled shaft for concrete piles may be accurately located with proper batter and penetration easily obtained. In many cases, this can be done without disturbing the original structure. Depending on the location and traffic volume, drilling can be done either by on or off-track equipment. Therefore, if con-

ditions warrant, very little or no track time and slow order time is needed.

An example of this savings can be noted in the renewal of a through truss span with prestressed concrete or deck-plate girder spans. In order to build the intermediate bents using pipe or H-beam piling, it would be necessary to remove parts of the overhead steel bracing to permit the pile-driver to be positioned to drive the piles. In most cases, the span being replaced is weak or damaged. Therefore, extreme care must be exercised in removing any steel members. ne can readily see that the labor cost of this extra work and the time lost due to the clearing of trains can build rapidly. Not only is the construction process slow and costly, but the slow orders usually issued can create related problems. However, if an off track drilling rig would be used to drill the shafts and place the concrete, no track time or slow orders need be issued. Maximum speed can be continued throughout the construction period until final preparations must be made for removal of the span. The savings on labor alone can be as high as 40 or 50%.

Limiting conditions for cast-in-drilled-hole concrete piling

In addition to the above advantages, there are a number of limiting factors that must be satisfied before cast-in-drilled-hole concrete piling may be considered economical.

(1) The availability of concrete is obviously important. The source of the readymix concrete must be within a tolerable distance and placement in the form easily and economically achieved.

(2) The availability of drilling equipment and jobsite conditions are additional limiting factors to this type of construction. This is particularly true when contracted off-track drilling equipment is required. Because off-track equipment requires relatively level operating surface, a high cost of site preparation is impractical.

(3) Subsoil conditions are the main limiting factor when making preliminary designs for cast-in-drilled-hole concrete piling. The maximum economic length of a cast-in-place concrete pile depends greatly on the efficiency of the drilling and pouring operation, but more heavily on the design depth of the pile.

Construction procedures

As stated previously, soil conditions are very important in using cast-in-drilled-hole concrete piling. Soil investigation can vary greatly in cost depending on the type and extent required. In most bridge construction, designers can rely on previous soil borings and pile penetration reports. If soil conditions are questionable or beyond the limits of the available reports, further exploration is needed either by company forces or private consultants who charge approximately $4 to $5 per foot. The main objective to keep in mind is to obtain a reliable report so that both design and an accurate material estimate can be made. However, allowance should be made for possible subsoil irregularities and corrected when drilling each hole.

Engineers have a choice to drill the shafts using company or private equipment and to operate on or off track.

The initial cost of an adequate company drilling rig for two shaft sizes is $25,000 to $30,000, excluding crane cost. The labor to drill a 36-inch diameter shaft is approximately $2 to $3 per linear foot.

Private drilling contracts are usually of two types. They are by the linear foot and by the hour, usually depending on soil and site conditions. The average cost of a 36-inch diameter shaft is $10 to $12 per linear foot or $60 per hour. Both of these rates include cost of drilling and labor for placing steel cage and pouring concrete. Using an estimate of $45 per linear foot for concrete, steel reinforcing and labor for forming and tying steel cages,

the total cost of a 36 inch diameter shaft is approximately $55 per foot.

The choice of using an on or off-track rig is a matter of engineering evaluation.

Depending on soil conditions, the type and procedure used for drilling the pile hole can vary. Three general conditions may exist. These are: (1) stiff clays or firm soils, (2) sand, gravel, or granular soils and (3) rock.

When a firm soil or stiff clay exists, an open auger is used. Since in this type of soil there is no problem with caving of material, either a straight shaft or underreamed footing can be drilled as required and the concrete pour can be made using conventional methods. The average length in a non-rock soil is 25 to 35 feet below natural ground.

In sand and gravel soils, two methods are commonly used: (1) a closed side cutting bucket inside a steel caisson, and (2) a wet-hole slurry and auger.

The closed side bucket travels inside a steel casing. The casing retains the hole diameter and seals the water out as drilling continues. In some soils, such as a dense sand, the casing may be difficult to pull after drilling is completed and concrete pouring has started. Therefore, the casing should be selected accordingly, having ample strength to withstand handling stresses and concrete and earth pressures, and must be water tight. After the hole has been sealed by the casing, a bailing bucket or pump can be used to remove the excess water. The closed sides of the bucket permit the excavated granular material to be removed from the hole. When the desired depth has been reached and the hole cleaned, inspection can be made and the steel and concrete may be placed

If difficulty is experienced in sealing the casing or if the casing is too hard to pull, a wet-hole slurry and auger can be used. In most drilling, one to three sacks of drilling mud is adequate to provide a proper slurry. Once the hole is completed the cage is placed and the concrete can be poured by using a tremie with a long tube. The length of the tube must be adequate to reach the bottom of the hole and care must be taken to keep it centered as it is pulled so that proper displacement of the slurry is made. Provisions must be made to have side doors or a sectioned tube in order that the concrete can enter the tremie and be discharged at different depths. In order to insure a solid pour without voids, soil seams or mud pockets, caution must be taken not to lose the concrete head or pull the tremie too fast.

Rock drilling can be the slowest type of drilling, but is offset usually by the short depths which must be drilled. Usually, engineers require an average of five feet of penetration into solid rock. Often it is necessary to drill through a thin rock layer to obtain adequate penetration or bearing in a deeper soil. Most thin rock layer drilling is done by using a chipper bar to break up the rock and then excavate by auger or bucket. A core barrel which may have teeth or rock bits attached to the rim of the barrel is used when the rock formation is thicker. Steel and concrete can be placed using conventional methods with no difficulty.

The reinforcing steel cage for the shaft, consisting of longitudinal bars and spiral or lateral ties, should be completely assembled before placing into the shaft. Generally the concrete pour should be started immediately after excavation of the shaft is completed and the reinforcing steel is placed. The reinforcing cage should be securely supported to prevent slumping and misalignment during the concrete pouring and casing extraction. At the time concrete is placed, the shaft should be free from accumulated seepage water and all loose material removed from the bearing area.

Concrete placing should be made continuous with time intervals scheduled to allow for pulling casings, plac-

ing forms and other operations necessary to the placing operation. In order to keep concrete from sticking to the casing, the casing wall should be oiled and can be rotated or extracted with short pulls. The elapsed time from transport truck or mixer to placement in the shaft must be watched closely and not allowed to exceed the allotted time. A retarding agent will extend the placement life of the concrete about 100%. Care should be exercised to prevent segregation while placing the concrete.

When the casing is to be removed, the removal should not be started until concrete pouring has started and sufficient head is developed inside the casing. Usually, a five to six foot head must be maintained to overcome the hydrostatic pressure. Extraction of the casing should be slow and at a uniform rate with close field inspection for upward movements of the concrete or steel and other signs that would indicate separation within the shaft.

Once the pile has been poured to ground line, several bent designs are available. A solid pier may be extended from the piling to the desired elevation. Column forms may be extended from the piles by using pipe or reusable metal forms. When a pile bent is specified, the cap design must be considered when forming the column. A common method of cap-pile connection used on many railroads is to weld the steel pipe form to a steel plate cast in the bottom of the cap. When reusable forms are used, a short piece of pipe, approximately 18 inches long can be placed on the top of the form, providing a welding surface and a form to make cutoff. The use of reusable forms can be another point of savings, since the forms can be rented for about one-third the cost of a permanent steel pipe form. All of the pier or pile bent construction can be done with little or no adjustment to the existing structure.

Conclusion

In summary, cast in drilled hole concrete piling can be economically used when soil conditions warrant, drilling equipment and construction material are available and jobsite conditions are favorable. In most cases, all pier and pile bent construction can be done with little or no interruption to regular traffic. This savings feature can make cast in drilled hole concrete piling the most practical method of railroad bridge construction.

Care and Use of Wire Rope and Slinging

By Norbert Freeborn
Broderick & Bascomb Wire Rope Co.

Put first slide on— This program, this afternoon, is on lifting. Since we are Wire Rope people, I will confine my remarks to the subject of Wire Rope Slings.

Next slide— You have before you our Wire Rope Manual on Selection—Safe Rigging—Inspection of slings.

We prepared this manual to show that like your Railroads, we too continue to improve our service to our customers.

It is our feeling that an extra ordinary lift is well planned, and because it gets a great deal of attention, all safety precautions are taken. And usually, the lift is made without any difficulties.

We believe that 90% of all lifting problems occur during the normal working period. We compare this with driving an automobile; as a new driver we were alert and gave each sign and signal our complete attention. As we added miles and age, however, our driving became more mechanical and I am sure that we can recall an occasion when we left home in the morning and drove to the office so preoccupied with other thoughts that we were not conscious of the many traffic signals we encountered and obeyed. We will readily admit that this is not attentive and alert driving.

We feel that something similar happens to the regular lifting situation. It is too often taken for granted, and we feel it our duty to call your attention to the basics of sling safety.

We do not believe that there is such a thing as a routine lift. Each one is different and should be considered in that light.

This manual is designed to coincide with our 35 MM slides and we ask you to follow along as we narrate.

The first page outlines the contents and we will talk about each item with the exception of the rolling hitch.

Shall we begin—

Braided Versus Standard Slings

Wire rope slings are generally placed in either of two categories—braided or standard. Braided slings are composed of multiple braided wire rope or parts in the sling body while standard slings are usually constructed with one piece of rope. Variations of design, types, fittings plus strength tables and detailed dimensions are shown in Broderick & Bascom's Rigger's Handbook.

Braided Safety Slings

The number of parts in a braided safety sling can be from 3 to 32 parts, braided into either a round or a flat section. The usual and most often used braided sling is made of 8 part construction. Its construction gives it flexibility far beyond any standard sling. Capacities range from 400 pounds to 400 tons. Ease of handling, gripping action and resistance to kinking cannot be equalled.

Broderick & Bascom manufactures two types of braided slings—BRAID-LOC and YELLOW STRAND Braided Safety Slings. The patented BRAID-LOC sling offers additional strength for the same weight and size of other braided slings due to its unique loop construction, compression sleeve strength and use of wire rope with a

steel core. YELLOW STRAND Braided Safety Slings, surpassed only by BRAID-LOC, offer the largest variation of braided slings featuring exceptional flexibility, non-slip gripping and maximum safety. Braided Safety slings may be made with either extra-high strength POWERSTEEL or high-strength YELLOW STRAND wire rope.

Standard Slings

Usually made of 6 x 19 or 6 x 37 construction wire rope with clips, splice or compression sleeve to form a loop. Except for the compression sleeve with a Flemish eye splice to form a loop, there is decreased value of strength in the total sling capacity compared to a straight piece of rope without loops or fittings. BROLOC slings have a true Flemish eye splice with the ends of the strands being held to the body of the rope with an all steel compression sleeve.

Consult the RIGGER'S HANDBOOK for capacities and detail information on the many varieties of YELLOW STRAND standard slings available. They include Cable Laid, Endless and Grommet type slings.

Wire Rope Slings

Selection of the proper sling for any lift requires consideration of many factors such as safety, ease and speed of handling, life expectancy of sling and cost. Understanding the various types of hitches will assist you in selecting the best sling for your lifting requirements.

Types of Hitches

Choker Hitch. This is a contact sling hitch in which the sling passes entirely around the load. In its simplest form the sling has a loop or eye on each end, and is referred to as a choker sling or choker. One loop is passed through the other forming a slip noose. The hitch is usually used singly and has a rated capacity of 75 percent of full strength of the sling.

Basket Hitch. This hitch can be made with the same sling by passing the choker sling under the load, both loop eyes going to the crane hook. Chokers are used in pairs where load is carried suspended and singly where one end of load must be raised. Load rating can and does vary. A safe figure is double that of a choker hitch where square corners are encountered. Rating must be reduced if sling legs deflect from a vertical position.

Another method of calculating the load rating of a basket hitch is doubling the load rating of a single direct connected sling. This figure should be reduced for sharp bends or other conditions which do not occur in a verticle sling.

Direct Connection Hitch. This hitch is made directly from the crane hook to the object to be lifted, usually being attached to the load by means of a hook or shackle. A directly connected hitch can be made with more than one sling leg. When two or three leg slings are used, the center of gravity of the load will be directly under the crane hook on a freely suspended load.

Leg lengths must be accurate if the object is to hang level. In a four-leg sling, any variation in leg lengths, when attached to a rigid load, could throw the entire load on two legs, the other two legs merely restricting the load from overturning. If the hookup is such that two, or even three legs of the sling are taking the load, the safety factor is reduced. In flexible loads, such as long wide steel plate, this condition is not apt to occur.

Rolling Hitch. When it is necessary to roll a load, it is essential to determine the type of sling to be used and also the type of hitch. It is of utmost importance to see that the sling rolls with the load. As an example, turning an open-end load such as a boiler could be handled by using two endless ropes forming a basket hitch around the load.

The opposite wire rope loops would engage sheaves on the crane hook. If the article handled is unbalanced so that it might roll suddenly of its own accord during the turning process, it is necessary to provide additional means to control its movement.

When the object to be turned over is in the form of a ring, the procedure is identical except a choker sling is threaded through the opening and through the sheave. After this both ends of the choker are then connected together with a shackle or link forming an endless sling. As this connection will not pass around the sheave and might damage the object to be turned, the movement is limited by the length of the choker sling or the headroom.

Conditions to Consider For Proper Rigging

Abrasion. A basket hitch made with a choker sling having both loops in one crane hook should not be used for turning loads because of the inevitable movement of the load against a small portion of the sling. This movement causes abrasion of the individual wires in the rope and possible actual failure of the sling. Where two crane hooks are available, a pair of two-legged bridle slings should be used, one placed to unwrap while the opposite sling wraps around the load. Slings should not be attached to the ends of a rolling load if either slippage or rubbing of the load against the sling will occur.

Design Factor. This is the number of times the recommended lifting capacity is multiplied to equal the ultimate or breaking strength of the sling. Wire rope slings are recommended for use at a design factor of 5 or more. This design factor is designated to take care of any overload that cannot be foreseen, such as shock loads, incorrect use or other unusual conditions. Catalog ratings are based on new slings. Load ratings on worn slings should be reduced. Never use a sling with a design factor less than three.

Sling Angles. Sling angles are shown in different ways in various catalogs. Regardless of how the sling angle is stated, or the method used to figure the stress in a sling leg, the load rating should be the same.

The following description applies to the included angle measured between one sling and a plumb line suspended from the hook.

A lot of misunderstanding results from the change in carrying capacity of a sling when the leg angle is changed. Actually, there is no change in the tensile strength of the sling leg. What happens is that the operator is picking the load straight up or vertically, but the sling leg is pulling at a disadvantage. For quick figuring in the shop, a 30 degree included leg angle causes a loss in lifting capacity of 15 percent, 45 degree leg angle 30 percent and 60 degree leg angle 50 percent. Not 100 percent accurate, but easy to remember and slightly on the safe side.

It is always good practice, within limits, to keep the sling leg angle as small as possible. However, the length and width of the load, the sling leg length or the available headroom sometimes determine the sling leg angle.

It is neither economical nor good practice to exceed a 60 degree sling leg angle. Angles greater than 60 degrees not only build up tension in the sling legs out of all proportion to the weight of the load, they also create a much greater "in-pull" on the ends of the load. This produces eccentrically loaded column effect. Long slender objects have a tendency to buckle. Included angles greater than 60 degrees indicate some thought should be given to the use of a lifting beam in connection with the lift.

Lifting capacities on slings are misleading unless the sling angle is stated. A sling that will handle 10 tons at 15 degrees included leg angle will only handle 5 tons if the angle is increased to 60 degrees.

Shock Loads. Crane hooks should be

started slowly until the sling becomes taut and has the load suspended. The lifting or lowering speed of the crane should be increased or decreased gradually. Sudden starts or stops place heavier loads on the sling. This action can be reasonably compared to jamming the brakes on a speeding automobile.

Weight of Loads

Always study your load and determine the weight and the strength of the connections. Never underestimate the weight. If you are attaching the sling to lugs, are they heavy enough to take the load? Always use a sling of ample capacity. Broken bones or lost time costs more than the most expensive sling on the market today.

Guide to Estimate Working Load Of Wire Rope. Catalogs give the proper load rating for ropes. *When no catalog is available, the approximate safe-working load can be figured. Simply square the diameter and multiply by 8. The answer is the working load in tons.* This must be reduced by the efficiency of the splice for a straight pull-to-pull load. Other reductions must then be made for the type of hitch, or the leg angle.

Used Rope for Slings. Wire rope used for sling purposes is usually of improved plow steel grade of either 6 by 19 construction or 6 by 37 construction. There is very little saving in cost in using rope of less tensile strength as the labor involved in making a sling remains constant. Similarly, there is no real econmy for using old hoisting ropes to make slings. If a rope is no longer serviceable as a hoist rope, the mere action of splicing loops into the ends reduces its strength still further and it is of little value in picking up heavy loads. In fact, it is a used sling from the very start.

Slings made of 6 by 19 rope have 114 individual wires running the entire length of the rope. This means that the failure of a single wire reduces the strength less than one percent. With 6 by 37 construction having 222 wires, the failure of a single wire reduces the strength less than ½ of 1 percent. Compare this to a load suspended by a rod, its failure would be 100 percent or disastrous.

Lubrication. While the rope is oiled during manufacture, overloads cause the rope to pull down in diameter, squeezing the grease out. If this happens to any great extent, the sling should be given an occasional coating of light oil to prevent rust. A rusted rope sling has lost its resilience and should be discarded.

Fittings. Plain loops can be clipped,

EFFICIENCY OF WIRE ROPE CONNECTIONS AND SPLICES

Type of Connection	Efficiency
Wire Rope	100%
Sockets—Zinc Type—properly attached	100%
Wedge Sockets	70%
Clips—properly attached	80%
Plate Clamp—Three Bolt Type	80%
Spliced Eye and Thimble:	
1/4″ and smaller	90%
5/16″ - 7/16″	88%
1/2″	86%
5/8″	84%
4/4″	82%
7/8″ and smaller	80%

spliced or swaged. Thimbles should be used to prevent wear to the actual rope. Thimbles can be used with a variety of fittings such as hooks, shackles, links, rings, turnbuckles and plate clamps. Where a loop is not desired, the rope ends can be fitted with either open or closed sockets. Where sockets are used, they should be attached with virgin zinc after the rope has been cleaned of all foreign matter. In putting on a socket correctly, cleanliness become absolutely necessary if you want a good job.

Hooks. Any hook is simply a curved beam and the strength can be calculated on that basis. (A) You will often see hooks on which the load is suspended on the point. (B) When used in this manner, the stress set up in the hook reduces the load carrying capacity as much as 50 percent. Side pull on hooks also sets up a bending action that reduces its lifting power.

This is also true of connections attached permanently to the load itself. These connections vary in size and shape. Cast lugs, eye bolts or "U" bolts are in this category.

INSPECTION OF WIRE ROPE SLINGS

Guidelines

The following information is a guide to use for inspecting wire rope slings. Expensive objects to be lifted, personal injury or property damage factors determine the frequency of the inspection.

All slings should be inspected at some regular interval of time. This interval can best be determined by the user and is dependent upon the particular use of the sling. The interval must be such that safe use of the sling is assured at all times.

A sling should be inspected after any unusual situation that may have damaged it, such as overload, accident or fire. It should not be placed back in service until its continued safe operation has been verified.

Inspection should be performed only by persons with sufficient experience and knowledge to properly apply the following criteria for rejection when examining a given sling. This is particularly important, since each of the 11 items listed depends to some extent upon the judgment of the inspector.

The user should store slings in a manner that will protect them from damage by moisture, heat, corrosion or physical abuse.

The user should determine that the sling is being used in accordance with the rated capacity as listed in the current catalog of the sling manufacturer.

The following should be considered criteria for rejection.

(1) Six randomly distributed broken wires in one rope lay or three broken wires in one strand in one rope lay. Snagged, nicked or severely bent wires count as broken wires.

(2) Abrasion, scrubbing or peening causing loss of more than 1/3 the original diameter of outside individual wires.

(3) Evidence of rope deterioratior from corrosion.

(4) Kinking, crushing or other damage that results in detrimental distortion of the rope structure.

(5) Any evidence of heat damage including bare electrical conductor, ground, or welding arc.

(6) Any marked reduction in diameter either along the entire main length or in one section.

(7) Unlaying or opening up of a tucked splice.

(8) Core protrusion along the main length.

(9) End attachments that are cracked, deformed, worn or loosened.

(10) Any indication of strand or wire slippage in end attachments.

(11) More than one broken wire in vicinity of a zinced-on or swaged fitting.

BE CAREFUL—THE TOES YOU SAVE MAY BE YOUR OWN

Guide for the Reduction of Total Sling Costs

(1) Overloading causes accidents. When in doubt, use a larger sling.
(2) Start and stop slowly — Sudden starts or stops increase the stresses in the crane ropes and the sling out of all proportion to the load.
(3) You are asking for trouble if you over-run the limit switch on your crane.
(4) If possible, set the load on blocks. Pulling a sling from under a load causes abrasion and curling. Makes sling harder to handle on the next lift.
(5) Sharp corners cut slings. Use protector arcs or blocking.
(6) Store in dry room. Moisture or acid fumes weaken slings.
(7) Use moisture-proof covering for the same reason as above.
(8) Periodical inspection pays dividends.
(9) Avoid handling hot material with contact slings. The strength goes down as the temperature goes up.
(10) Dropping castings on slings or running trucks over them causes damage. Hang them up when not in use.
(11) Use hooks properly. Point loading reduces carrying capacity.

President Fuller: I am going to ask President Gunderson to introduce the next speaker.

President Gunderson: Thank you. It is now my privilege to present one of the men whom I passed over earlier this morning. This was done only to give him a little more adequate recognition.

This relatively young man, born in Grand Forks, North Dakota, in 1920, lists very little in his biography before he obtained his bachelor's degree at Wharton School at the University of Pennsylvania, from where he went on in advanced training at the Harvard School of Business Administration. I can assure you, however, that I have heard on more than one occasion that he started railroading on the Great Northern as a gandy dancer during summer vacations. I'm sure this information was given only to convince me that any unrealistic budget requests would be looked at from the perspective of experience.

Following college, he served four years in the Transportation Corps of the U.S. Army, leaving that string as a major.

He returned to the Great Northern and advanced in operations from assistant trainmaster to assistant superintendent of the Cascade Division. Incidently, I believe I have been told that division is larger than our railroad.

He was appointed vice president of the Minneapolis & St. Louis in 1956. He moved to the Chicago, South Shore & South Bend Railroad as vice president and general manager, and became president of that company in 1961.

He moved east in 1966, joining the Western Maryland Railway Company as vice president of sales. He was elected a director of the Company as vice president of sales. He was elected a director in 1969, a commission he now holds.

He is very happily married to his charming wife, Marjorie, and they have four real nice children.

He belongs to more clubs and chairs more committees than I have time to enumerate. He plays good customer golf and he is one grand person to be with. I have worked closely with him, I have great respect for him, and I assure you he is well qualified to address us this morning. I am honored, indeed, to present to you Mr. W. P. Coliton, whom I can now call Bill. (Applause)

The Financial Problems of the Railroad Industry, Particularly of Those Railroads in the East

By W. P. Coliton

President, Western Maryland

W. P. Coliton

You didn't have to be nearly as nice, Roy, because you are retired and if you say something bad, there isn't a damned thing I can do about it.

And as for my golf game, the Western Maryland Railroad might be in tough shape, but it isn't, because I spend a lot of time on the golf course. We have 600 golfers at the Baltimore Country Club and I have the highest handicap out there. I have a 34 and there is no one else even in the 30's, that's how bad I am. The golf pro asked me would I please take his name off my golf bag when I go out of town because I embarrass him with my golf game. (Laughter) That's pretty bad, believe me.

If you fellows come to Baltimore in your travels, bring your golf clubs along and we'll get out on the golf course and I'm no competition. It is a lot of fun. I enjoy playing golf.

It's nice to be here this morning. I see an awful lot of old faces, having been in the Operating Department up in Minneapolis, in the Operating Department of the Great Northern, and working east. While traveling over the country you meet a lot of people in all departments and you end up with lots of friends, I hope, and it's nice to be in Chicago even if I'm leading off the program.

I was planning on using some slides but I'm afraid if they turned the lights out everyone would be sound asleep by the time they turned the lights back up again. So we're going to keep the lights on while I talk.

I wasn't here yesterday morning when Mr. Biaggini talked. I don't know what he had to say. I'm sure he was interesting because he is a real interesting guy.

I think it is interesting that you should hear the viewpoints of the chief executive of a large profitable western railroad, and then this morning from a small profitable eastern railroad, the difference between the large and the small. And I say profitable on the Western Maryland because we do expect 1972 to be profitable. We had a bad 1971. We lost $3 million for the year but I have every reason to believe we will come out of '72 in the black.

As Roy has told you, my experience has been in the track department and as such I feel I can at least talk to you on an equal basis about the railroad industry as a whole, the eastern rail-

road picture may be as a part and the maintenance of way picture as a segment, because he told you I worked from Seattle, Washington, to Minneapolis, Minnesota, to Chicago, Illinois, to Baltimore, Maryland, in all phases of the industry. And if I get transferred again, the next time I'm going to be out in the middle of the Atlantic Ocean, I guess, because I can't get much farther east. And as he told you, I started my railroad career in 1935 in the Track Department of the Great Northern, working through various departments.

I have to tell you a little story about my return to the Great Northern after World War II. I had spent three years in North Africa, Corsica, and Southern Italy. During that time the temperature had never been below freezing in the three years I was overseas. The first thing the Great Northen did was transfer me up to the northern part of the Messabi Division in northern Minnesota in the wintertime to relay steel. Up there, because the ore trains move in the summertime, they did their rail relaying in the winter. They gave me a steel gang of about 50 Finlanders. They never missed a day because of the cold weather, but I'm telling you it was a wild experience. I put on all the clothes I owned. It never got above 20 below and it hovered between 20 below and 40 below for three months. And if you are ever going to decide to stay in railroading, that was a good test of my durability.

Anyway, I stuck it out and we got the steel relaid. Thank heavens for the Fins because I would never have gotten it done. The worst part about it was the outdoor plumbing. I never became accustomed to that.

Anyway, before I get along here too far I want to thank you all for the great tribute you have paid the Western Maryland Railroad by electing Roy Gunderson as your President for the past year. I checked into the Conrad Hilton and I picked up the magazine "Where" and there was his picture right on the front page. They usually have a picture of a pretty girl on there but they had Roy Gunderson this year. I don't know whether that's an improvement or not but it was nice to see his picture there.

I know he's done a great job for your organization because he's always done a great job on anything he has ever undertaken. He has performed magnificently for us on the Western Maryland in Baltimore for many years and we're going to miss him in Baltimore. Now that he's moved to Florida we hardly ever see him any more. But we on the Western Maryland and I'm sure all of you join me in wishing him many happy years of retired life in sunny Florida.

To get back at the subject at hand, in trying to grope around for a good summary of the railroad problem, we find lots has been written over the years and a great deal just in the past few weeks. It's current subject, a current topic, and there is lots written. I try to read as much of this as possible. Some I agree with and some I disagree with. In all that I have read in just the past month, I think one of the best short and to the point summaries is what the two Trustees of the Lehigh Valley Railroad said to the judge overseeing their bankruptcy and report just this last month and I might quote what the Trustees said.

The Trustees believed that a significant structuring of the northeastern railroads is necessary if the carriers seving this territory are to continue as private enterprises. This conclusion is based on the belief that there is a declining rail transportation market in the northeast and there are too many railroads participating in this diminishing market.

Everyone is aware of the dramatic effect of the opening up of the St. Lawrence seaway.

I think he pretty well sums up what he has to say and the conclusions, as in most reports of this kind, and he sums up his analysis as follows:

"As has been true for many years and is likely to be the case for many years to come, the railroads are heavily oriented to the transportation of bulk commodities."

The only thing I can say about Agnes, in my job, being away from what is going on around the railroad, I lose contact with the employees, the men and the people who run the railroad and the people who maintain the railroad. When Agnes hit, our Vice President of Operations, whom you didn't meet, but he's sitting over there, was way up in Canada, a thousand miles from nowhere. And we don't have an awful lot of supervision, so Roy and I had to go out, put on our hip boots and see what the hell was going on, what the trouble was and how much damage we had. And I did have an opportunity to get back down and get acquainted with the section foreman and the roadmasters and the whole track department. This all happened just before the Fourth of July week-end, so the Fourth of July this summer is just kind of a blur. Everyone pitched in, they did a real great job, and I suppose only in an emergency like that do you find out how truly dedicated and what a grand bunch of people you have working for you.

I don't know what the final result of tropical storm Agnes is going to be for the railroads in the east. We have three bills in Congress from which we are trying to get some help. I talked with the office of the Federal Railroad Administrator. I see that John Ingram was on the program here yesterday, but he sent another man because he is off in Russia at the moment. But the office of the Federal Railroad Administrator, who are following these three bills, are not nearly as encouraged as they were a month ago. They seemed to be quite enthusiastic that we were going to get some help or something done. But they were kind of down in the mouth yesterday.

We got one of the bills pretty much through committee and at the last minute Hartke added some amendments on the bills, one bill that looked pretty good, making it so undesirable that the Administration just can't buy the bill in that form. He put in restrictions on dividends and put in parts that the railroad industry practically has to be nationalized before we get any help. This makes the bill unpalatable and I just don't think we're going to get any help. That's the best I can tell you as my feeling for what Congressional action might happen. I do hope that something does happen but I'm not very enthusiastic.

Well, do I have a solution to the eastern railroad problem? I certainly do not or I wouldn't be here today. I would probably be president of the Penn-Central or the Chessy System, C&O/B&O, that's a nasty word. Now we call it the Chessy System. I think our answer lies in applying parts of various solutions.

First of all, do the American people want a stable, viable, sound railroad system? Probably 90% could care less. They have their own problems. Given a choice, I think most people agree that we do need a railroading system. (Applause)

President Gunderson: Mr. Coliton, I think the reception from the audience speaks a little more eloquently than I can. We do thank you for being with us this morning.

Now, as I explained to you earlier, you are welcome to stay with us but we'll be understanding if your commitments require you to leave. This is quite a financial center out here, isn't it? Don't you have some nice rich friends who can help you.

Mr. Coliton: No, fortunately. I tried to borrow money when I first moved to Baltimore in Chicago but they never heard of the Western Maryland. They have some great financial institutions but New York is closer. It's easier to get money in New York, so that's where I'm going from here. Thanks, anyway.

President Gunderson: Well, that's

fine. You probably didn't notice but when I registered, you now have a branch office down in Winter Haven, Florida. Western Maryland Railway Company, Winter Haven, Florida. I'll send you a bill for that later.

I'm very glad Mr. Coliton explained the decreases in the financial situation of our Western Maryland without blaming me too much before my retiring. He told me many times that I sure spent a hell of a lot of money. And I suspect that Robbie, Clarence Robinson, will be hearing that, too, in the future.

Now, Mr. Coliton, I personally hope you continue your capable management of our company because I already like to get these retirement checks and I know that I am going to need them for many, years.

Mr. Fuller, I now return this to you.

President Fuller: Thank you, Roy.

One of the most interesting construction projects in many years has been underway across northern Arizona. Our next speaker is and has been very intimately involved with this project. He is a graduate of the University of Santa Clara, California. He was employed in the Engineering Department of the Western Pacific Railroad for about 20 years.

After two years with a railroad contractor, he became engineer of track and structures for the Bay Area rapid transit at Baton at the time of the planning and designing of all the bridge structures, tunnel structures and track structures, et cetera.

Since 1970 he has been chief railroad engineer for International Engineering Company, a subsidiary for Morrison-Knudsen contractors.

I would like now to present Mr. Jim Pearce. (Applause)

The Construction of Black Mesa & Lake Powell Railroad

By J. F. Pearce

Project Director, Morrison-Knudsen

J. F. Pearce

Thank you, Tom, members of the Roadmasters' and Bridge & Building Association:

I suppose all of you have heard the younger generation's reaction concerning movies, plays, and TV programs. If you haven't, they say, "To attract an audience you have to have a sexy title." One young secretary told me if I really wanted to pack the house I should retitle my address, "All The Things You Have Always Wanted To Know About the Black Mesa and Lake Powell Railroad—But Were Afraid To Ask."

I was really concerned last January when I received a call from Bill Autrey of the Santa Fe telling me to circle September 19th on my calendar because he had volunteered me as a speaker. Service in World War II taught me about those who volunteered for anything. But in the last nine months we had made some substantial headway in our project, enough that the new ideas we're using may be of interest to you, the real grass roots people concerned with maintenance of way programs.

For those of you not familiar with the BM & LP, a little background might be helpful. In 1968, 5 privately owned electric utilities and the U.S. Government were all looking for locations to construct a generating station to provide electrical service for their anticipated increased demands due to the projected growth of the west over the next 5 decades. If the so-called Central Arizona Project was approved, the Government will require power to make lifts from the Colorado River to flow water from the western border of Arizona to the central and southern portions of the state. The 5 utilities involved were: Arizona Public Service Company, Los Angeles Department of Water and Power, Nevada Power Company, Tucson Gas & Electric Company and Salt River Project, with Salt River Project acting as Project Manager for the group.

The generating site, near Page, Arizona, near the shores of Lake Powell—in northern Arizona near the northern end of the Grand Canyon—was chosen because of the need for cooling water. The coal mine, however, was located at Black Mesa—some 70 air miles east of Page. The generating station will have a total capacity of 2,250 megawatts. The station would burn coal at the rate of up to 23,000 tons daily when operating at full capacity.

In 1970, Morrison-Knudsen Company, of Boise, Idaho, and its subsidiary International Engineering Company, of San Francisco, were selected to design and construct the railroad to

transport the coal from the loading site, near the mine, to the generating station. At the outset, it was obvious that the general alignment of the railroad would necessarily wander through a large portion of the Navajo Indian Reservation and perhaps a portion of the Hopi Reservation.

Because the new railroad would not connect directly with any existing operating railroad, the owners asked M-K to study the economics of two alternates for operation—one using standard diesel electric locomotive power and the other using pure electric power. To achieve the lowest possible transportation costs, we chose the unit train concept, establishing a balance in the loading, hauling, and unloading—consistent with supply, consumer needs.

Maintenance costs—their amortization requirements

In March 1970, a team of locating personnel—engineers, hydrologists and geologists—began reconnaissance of the area. Four alternate routes were ultimately studied. The chosen route contained the following track geometry: 78 miles in length, 2 degrees-30 minutes maximum curve, 0.8% compensated ruling grade with loaded train and 2.4% compensated ruling grade with empty train. The economics of diesel electric and pure 25kv electric were nearly exactly the same, based on the required 35 year life. However, 50 kv power showed advantages for the electrical, assuming the breakthrough in technology could be developed.

The 25 kv system required four, or possible five, substations, with the added cost of 30-40 miles of overland transmission line. The 50 kv system needed only one substation which could be located at one end of the railroad. Working with General Electric, we developed a warranty for an enboard circuit breaker for the 50 kv locomotives and designed a new catenary system with low line impedances.

The success in automation shown during four years of operation on the Muskingham Railroad in Ohio, allowed us to design a similar system for the BM & LP. There will be an observer in the cab of the lead locomotive, with manual controls to override the automation—should the circumstances require.

We chose a single train with three E-60-C GE locomotives with 6,000 equivalent horsepower each, and 73 rapid discharge dumping cars. Each car—62 ft. long by 10 ft. wide—will carry 122 tons of coal. They are equipped with four aluminum rapid discharge doors, F couplers, 38-in diameter wheels, and special snubbing devices have also been added.

Automatic door movements

The doors will be automatically opened by a separate 24-volt dumping system with electrical contact made through a dumping shoe on the side frame of the track. Positive polarity will open the doors on four cars at once —and a negative polarity will close them individually. The coal is to be dumped into a closed underground hopper, which is capable of holding the coal from one train within its 390-ft length and 90-ft. depth.

The train will be loaded as it passes along one of two tracks, each passing through twin concrete loading silos, 47 ft. in diameter and 200 ft. high. The two silos over each track represent ½ of the total of a four-silo complex. Any two silos in the complex are capable of holding enough coal to load one entire train. Only one train will be on the system at any time, with loading and unloading loops at either end of the 78-mile main line. The train will make the 78-mile trip, including loading and unloading, in less than 8 hours, thus, allowing three round trips to be made each 24 hours. The design provides for hauling enough coal in six days to satisfy the burn rate of 23,000 tons daily for a seven-day period.

Now for the portion of the railroad

which most of you will be able to relate to.

The roadbed is 32 ft. wide, which provides easy parallel access for maintenance purposes. It is designed with 12 inches of select material rolled and compacted to 95% density as subballast. The entire roadbed was built by adding water, as necessary, to achieve a compaction density of 90%.

To accomplish this, an 8-inch water line was installed along all 78 miles of the main line. Lift stations were installed at 11 reservoirs, which are spaced approximately 7 miles apart. Some 250 million gallons of water were used in compacting the roadbed and reseeding the borrow areas. Track ballast will conform to a modified AREA size #4, ¾ in. by 1½ in. crushed gravel. The ballast was produced in a plant we constructed in Utah, some 26 miles from the generating station, and trucked to a stock-pile area at the plant.

Gerwick RT-7 prestressed-concrete crossties, weighing approximately 700 lbs. each, are laid at 26½-in. centers. Treated wooden switch ties are used, as are treated 7″ by 9″ by 9′ 0″ crossties at the grade crossings.

The rail section throughout, is CF&I 119-lb. control-cool rail, which was welded continuously into 1,440-ft. strings at a portable shop welding plant brought to the generating station by the Holland Company. These continuous strings were temporarily stockpiled at the unloading site before being loaded, eight rails at a time, onto M-K's rail train.

The entire M-K rail construction complement was trucked to the generating station over 150 miles of highway, after being off-loaded from the Santa Fe yards at Flagstaff, Arizona. The complement includes: three, 3,600 horsepower diesel electric locomotives, 29 ballast cars, and 28 specially equipped CWR cars. The rail is attached to the concrete ties with True Temper clips, with a 3/16-in. thick Syntax neoprene rubber pad, separating the rail and the tie. The ties were cast at the new Gerwick plant, constructed solely for the BM & LP, at Camp Verde, Arizona. The ties were trucked to sites along the roadbed at 7-mile intervals. The ties were then loaded with fork lifts onto specially designed tie trailers and trucked directly to the tie-distribution machine.

So that the tie trailers would not have to be backed long distances on the subgrade, M-K built a self-propelled turntable which operated just ahead of the tie distribution machine. The turntable accepts a truck, turning it 180 degrees and discharges the truck in approximately 1 minute. The crossties are placed on the subgrade by the distributor machine, on the exact center line, which is measured off a string line set along the subgrade, to guide the tie distributor, and to establish the finished grade for the subballast.

The subballast was trimmed with a No. 14 motor patrol automated blade. This blade automatically cuts to plus or minus ½-in. from the finished grade elevation. The ties are indexed by the distributor to the center line and then placed precisely at 26½-in. centers using limit switches tied to sprockets, connected directly to the axle of the machine. We averaged approximately 8,500 ft. of tie placement per 8 hour shift.

Clips, bolts, and pads were distributed manually ahead of the rail-laying operation. The rail was pulled from the M-K rail train with a Pettibone straddle buggy. Every fifth tie was clipped to allow the rail train to move ahead, and a six-man crew followed behind to torque each clip to the tie with an initial 150 ft./lb. of torque.

The ballast train followed the rail-laying operations. As the ballast was distributed, the rail temperature was accurately measured and adjusted for temperatures of 10 degrees plus or minus, from the mean Page temperature of 80 degrees F. Should the rail temperature be higher than the allowable, the ballast train is equipped with

a refrigerated water car containing 18,000 gallons of water cooled to approximately 45 degrees F, to spray and cool the rail, bringing the temperature back to the desired range.

The ribbon rails are initially layed with standard 36-in. six-hole joint bars, which are later removed and replaced by Allegheny glued joints. When the replacement is made, the rail temperature is again carefully checked to allow the joint to be made within the temperature range.

Prior to making the final adjustment, the track is sledded with a Mannix Auto-Track Sled, placed a minimum of 8 in. of track ballast below the crosstie. Additional ballast is spread and the track is finally surfaced and lined, using Jackson 4500 tampers and Fairmont liners with lining attachments. Aluminum superelevation markers are epoxied to the crossties at appropriate locations to facilitate future maintenance of the track.

Bridge structures

The design called for only one major bridge. Three 54-ft. prestressed box girders were used in the bridge construction. The piers from streambed to caps are relatively high, reaching over 50 ft. With such a high fill involved, the fill was made across the entire streambed, which was dry during this construction. This allowed cost advantages in constructing a continuous fill and then later removing the portion to be spanned by the bridge. More importantly, it provided a well-compacted stable foundation adjacent to the bridge abutments to which we could land the abutments, and a well-compacted roadbed on the arriving and leaving sides of the abutments. Three grade separations are designed into the system—two allow highway traffic beneath the railroad—one allows the train to pass beneath the highway.

All of the other major structures are Armco Multi-Plate Super Spans. The structures range from 37-ft. - 4-in. wide by 25-ft. - 2-in high — 172-ft. long for the underpass, and 23-ft. - 7-in. wide by 28-ft. - 0-in. high — 210-ft. long for the overpass.

The minor structures are multi-plate steel and/or corrugated metal. There are 1,070 ft. and 11-ft. by 12-ft. pickup underpasses which serve jointly as vehicle, stock and drainage structures. Cattle underpasses are required because both sides of the right-of-way are fenced, using steel posts and 30-in. hog wire topped with three strands of barbed wire.

As I mentioned, the system is designed to operate fully automatically. That is, the automation will begin at the coal loading station, continue the train operation for the 78-mile trip, and includes the unloading operation. The loading operation is designed to load the train at a rate of approximately 7,000 tons per hour. Thus, a 73-car train will be loaded in approximately 1 hr. 45 mins., moving at a loading speed of approximately ½ mile per hour. The train will then proceed automatically over the main line at speeds up to 55 mph. An observer will be located in the lead unit to view the roadbed and track and do other trouble-shooting on board. He will have complete overriding capabilities to immediately take the train to manual operational mode.

The train, therefore, can be operated either manually or fully automated as the circumstances dictate. The automated system was designed and fabricated at GE's electric locomotive facility at Erie, Pennsylvania. At the unloading station, the train will pass through the fully enclosed hopper at a speed of approximately 4 mph. The entire train will be dumped in approximately 15 minutes. GE designed the automatic devices for the train operations using their patented "designator" system. 202 individual approach position indicators are located along the center line of the main track which transmit to the passing train coded messages setting automatically the throttle control or braking requirements

of the main line. It will automatically make air brake checks at each end of the line prior to advancing to main-line speeds.

Highway grade crossing lights, the train whistle and bell are automatically initiated through shunting of rails as the train approaches from either direction. The crossing protection power is fed from the 50 kv overhead catenary system, and this catenary system will be, to our knowledge, the first of its kind in the world. It was designed by International Engineering and its consultants. The train will travel the entire 78 miles of main line, while using only one substation located at one end near the generating station.

The catenary is constructed with wooden poles with steel cross arms. A 336 MCM ACSR messenger is used and the grooved contact wire is 4/0 hard drawn copper. A 336 MCM ACSR overhead return wire and lightning shield wire are located over the messenger and contact wire. Constant tensioning of the contact wire, wire messenger, and return shield wire is controlled by a series of pulleys and blocks with counterweights spaced approximately 1 mile apart. The maximum demand on the system is established at 11,000 kw with approximately 19,000 kw hours consumed per round trip, utilizing all 3 electric locomotives and a 73-car train.

Work is on schedule

The railroad, including the catenary, are presently under construction. We are on schedule and anticipate completion on schedule near the end of next summer. The generating plant is scheduled to go into operation in January 1974. I've brought a few slides which I will go through quickly. I hope they will perhaps give you a more complete understanding of some of the things I've described. May I have the first slide please.

(Slide) This map is intended just to orient you with respect to the location of the Black Mesa & Lake Powell railroad. It's in the northwestern portion of the state of Arizona. On the left-hand side of the map is the Grand Canyon. At the extreme top left-hand corner would be the Glen Canyon Dam and Lake Powell. The black spot at the top of the left hand corner is the generating station and the solid black line represents the Black Mesa & Lake Powell Railroad. The Black Mesa is down in the lower right hand corner and that is the location of the coal deposits.

(Slide) This is a quick slide to show some of you who would like to get out in that direction might find the fishing a little bit good. This is Lake Powell and the general area at the end of the railroad.

Archaeology is a problem

(Slide) This is one of our reconnaissance teams out doing the initial surveying. While the ground is relatively level at this particular location, we did run into other problems in establishing the main line. Some of those problems involved the archaeology.

This happens to be a Navajo hogan in which the Navajo is buried. His saddle and all his jewelry are in the hogan. That was his home. When he passed on they buried him there and unfortunately it was right on our center line. So we, of course, had to move the railroad, which we did.

(Slide) We also found an awful lot of advance work having to be done by the archaeologists ahead of us to clear out the artifacts and finds they knew were in this territory.

(Slide) This is a very small locker that the Navajo people and Hoppis stored their food in. Naturally, the archaeologists wanted to preserve all of these finds.

(Slide) This particular slide shows a whole dwelling. In fact the upper portion, the small portion in the second room had a skeleton of a small child who was buried there. They were quite excited about the finds because the

Hoppi nation had dated itself back around 1100 A.D. and the results of these finds indicated to the archaeologists, at least that's what they tell us, that some of the finds predate Christ as far as 500 years.

(Slide) We had some rather large cuts to handle on the upper reaches where we went through the gap grade and this is a simple picture of some of the grading operations in one of the cuts. That's solid rock.

(Slide) It is topped off with sand. You can see the blow sand at the top of the cuts. But once you broke through that you got into some pretty heavy grading.

(Slide) Now we constructed these cuts in a little different manner than they have been done before. We line drilled down the faces and shot, and then with Cats and No. 641 scrapers we were able to pull it out without tearing up too much equipment. It makes a real uniform plane on the cut slopes and I think it will be beneficial to the wind erosion they have out in that country. I don't think there is going to be too much scaling required there.

(Slide) This is a picture of one of our water trucks out on the grade. Of course, where you are talking about having a maximum rainfall of four inches per year, water is highly critical out in that part of the country and it is something we had to have in order to get the type of compaction we wanted on this particular railroad.

(Slide) This is one of the eleven reservoir sites that we used to bring the water the 78 miles. The pumping station is on the left. The 8-inch water line is flowing into the reservoir. That reservoir is lined with a thin lining of rubber which will be left there for use by the Navajo tribe after we leave to collect surface water.

Provide for highways

(Slide) this is the early construction of the highway railroad grade separation at mile 22 under the Navajo highway. The trains will pass underneath the highway at this point.

(Slide) This is an aerial view of that same structure showing the highway at the upper right and lower left and the detour road we provided around the end of it while we made the installation.

(Slide) Another photograph of the same structure as we are coming up with the backfill on both sides. There was an entirely different kind of rock formation at this point, which is at the lower end of the job, than we found at the upper.

(Slide) And that's a photo showing the finished structure with the highway back here, over on top.

(Slide) This is a slide showing the early installations on one of the larger two Super-Span grade separations.

(Slide) That's a photo of the finished product with the fill on top. Incidentally, that's the largest fill on top of a Super-span that Armo has been associated with as of this date. We naturally expect they will be greater but that's a pretty big one right now. Notice the concrete rings on each end, and the thrust beam concrete all the way along the spring line.

(Slide) That's the smaller of the two Super-Spans provided for one of the Indian service roads on the reservation.

(Slide) That is a photograph of the finished product after it had been completed. We think it is going to be a very serviceable structure for the operation it has been planned for. An 8-inch water line is shown going through one of the drainage culverts at the bottom, as I said, for the full 78 miles.

(Slide) This is a slide showing the big fill that we have. The clam bucket is not removing any fill. He is moving up to set the bench to allow us to drive pile for the abutment. We took the core cut with Cats and scrapers.

(Slide) There is the abutment with its forms. Part is already stripped after we had driven out.

(Slide) There we are, going up with

the columns. And as I said, from streambed to caps it is a little over 55 feet.

(Slide) These are the girders that were fabricated in Phoenix, Arizona, and trucked to the site for erection.

(Slide) This is a slide showing the first of the girders going in.

(Slide) This shows some of the handrail walk going on as the girders are erected.

(Slide) That's a slide showing the finished structure. Now the faces on the upstream side and the downstream side are fully faced off with some pretty good sized riprap and that is primarily there for wind erosion. Winds in this territory have been recorded at 75 miles per hour.

(Slide) This is a slide showing one of the pickup under-crossings that are used for the Navajos to go to and from their hogans. It also allows the cattle to travel from side to side without crossing the track and it also acts as a drainage structure.

Build large unloading hopper

(Slide) This is an aerial view of the excavation for the unloading hopper at the plant site. As I mentioned, it is 390 feet long and 90 feet deep.

(Slide) And this is a later slide after the concrete had been poured and a major portion of it had been stripped. The transverse conveyor coming out of the hopper is directly under the large van on the right. It moves to 72-inch belts out to a rotary stacker and the coal is stacked there.

That's the MK ballast train and the power that you see in the background moving into the maintenance house for locomotives and cars.

(Slide) Mr. Coliton talked about the environmentalists. We've had them up to our necks. I can say that literally on this railroad. These drawings indicate the extent that we were actually forced to do in replanting the parapets in that desert terriory. The total plants construction, the clients have told me they spent nearly $190 million in environmental improvements on the plant and the railroad.

(Slide) That shows somewhat the results of our efforts out there. It's artificially watered and we are very hopeful we can hold it at least through the winter when we finally get some rains out there.

(Slide) This is another slide showing some of the growth that we're getting in the borrow-pit areas.

(Slide) This is a picture showing the welding plant at Page adjacent to our main line. It is also shown primarily to show in addition to getting four inches per year of rain, you can also get it in about one hour or you can get snow. That's what we see in this photograph. We have had some pretty good snowfalls there for the Arizona desert.

Ties made in field

(Slide) This is a slide showing the long, line-production of the concrete ties at Camp Verde. 686 ties are cast in this plant daily. If you look carefully you can see the six strands traversing down through the forms from one end to the other.

(Slide) This is a slide showing the ties after they have been cast, the strands going through the ties being cut. That is an abrasive transverse wheel moving transversely across the end of the ties cutting all the strands.

(Slide) That is a photograph of the automatic picker. If you look very carefully you can see that the picker is dropped down and grabs hold of four strands at each end of the concrete tie and has now made the lift out of the forms.

(Slide) This is a photograph of the forklift lifting out the six ties on this bed. They come out like biscuits out of an oven.

(Slide) This is a slide showing the operation of the automatic No. 14 grader. The operator simply drives the blade down, keeps it on line on that string line and the blade is automati-

cally adjusted to cut within one-eighth inch of our fininshed grade.

(Slide) This is a slide showing the ties being removed from the stock pile out on the grade, loaded into the special tie trailers with the fork lift. You notice the two trailers are 2-tiered and that trailer will hold 84 ties.

(Slide) I understand John Weber stole some of the glory out of this turntable. But this is a picture of the turntable we built in the M-K shops in Boise to keep from having to back these long trailers with the big loaders down the grade which was a time-consuming operation. The turntable is self-propelled and moves ahead of the tie distributor. In this picture both gates, the fore gate and back gate, are both up and he is ready to start to turn the truck.

(Slide) There you can see spindle and the turntable revolving around the grade turning the trailer and the truck 180° and the four tires on each side with the power plant which are used to move it on grade.

(Slide) That whole operation that you saw, getting the truck on, raising the gates, turning the truck and lowering the gates is done within one minute, or approximately one minute.

(Slide) That's the full tie trailer with both tiers filled backing up to the tie-distributing machine.

Use tie-distributing machine

(Slide) Here is a photograph of the tie-distributor as the trailer backs up to lock with it. When that connection is made the tie-distributor is the sole motive power that is used to move itself, the tie trailer and the tractor on the front of the tie trailer down the grade. The operator of the tractor, the truck pulling the trailer, has only one function and that is to keep the fork over the string line, to keep the nose end of this trailer on line.

(Slide) This is a slide showing the receiving end of the tie-distributor with the ties then dropped off the endless conveyor on the tie-trailer truck on the distributor. As I said, this is the sole power to move all three units down the grade.

(Slide) This slide shows the tie-trailer passing ties to the tie-distributor. The tie-distributor is moving along the grade indexing the ties as they drop down off the string line and dropping them at 26½-inch centers.

(Slide) This is a little different slide showing how he is indexing off the left-hand side. You will see the fork over the string line and as the ties come down they check against that string line indexing themselves and then centering on the track center line and the limit switch kicks it free and they drop at 26½-inch centers.

(Slide) Here is a closeup view of the arms and the limit switch and the toggle switch on that side that releases the ties. You have some idea of how the spacing sets out.

(Slide) Here is a view from the back of the tie-distributor, looking at the alignment of the ties and the spacing behind. We think it is a pretty good line.

(Slide) This is a view showing the plastic inserts being removed from the concrete ties and at the same time the female insert down in the tie has to be blown out to be sure there isn't any sand or dust accumulated there before we start placing the hardware on.

This is a view with the Syntex pads down, the female insert now has the bolt back in it to seal off any blowing dust that would be in the territory and the clips are being manually distributed ahead.

(Slide) This is a view of one of our 3600-horsepower diesel-electrics being brought to the project. I defy anyone to really take some photographs of the Navajos when they saw that diesel electric going down the highway. You couldn't believe it. It was better than a circus.

(Slide) That's the same locomotive working on the grade.

(Slide) These are our specially fitted

continuous-welded-rail cars being unloaded at the plant site to be put into service. The whole consist, of course, locomotive, cars and ballast cars were brought in from Boise and will be returned to Boise the latter part of next month.

(Slide) This is a photograph of the rail train going out with only two tiers of rail. We loaded the rail on the rail train with the railroad division 8 rails at a time. And, for those of you who aren't familiar with that, we have some other photographs that indicate our method of loading ribbon rail. It is a little bit different than some others who have tried it.

(Slide) That's a straddle buggy going out ahead, placing the rollers to accept the rail, And the basket right under the boom is carrying the rollers that he puts out ahead.

(Slide) And there is the ribbon rail going down on the concrete ties. Those rollers are spaced every 20 ties. You notice that the bolts are 10-inch hold. In some areas we got a little sag.

(Slide) This is a photograph of the Pettibone Speed Swing raising the rail, taking the rollers back out, loaded on the truck and moved ahead.

(Slide) This is the small gang that is placing clips ahead of the rail train on every fifth tie so that the rail train can move out ahead.

(Slide) They are fastening the rail clips to the tie. Every tie is torqued up with a 150-foot-pound of torque.

In the labor category on our project we had about 82% Navajo employment in labor.

(Slide) That is a closeup view of the fastening system, the True Temper clip on 119-lb rail, Syntax pads.

(Slide) This shows the general alignment. And incidentally that liner is only out there because our string line was quartered around the curve and we wanted to get those chords out as soon as possible because the ties themselves, being 700 lb, allowed us to lay out ahead our skeleton track for five or six miles without worrying about sun-kinks. It is not a desirable thing but we found we could do that with dead weight.

(Slide) That track hasn't been lined. That is laid right off the rail train down on the ties without one piece of equipment going in there doing anything towards lining it, or surfacing it.

Get ballast locally

(Slide) This is the ballast plant that we built up in Utah out of river rock. We trucked over 400,000 tons of ballast down 26 miles into the State of Arizona and stockpiled it for our use in the plant.

(Slide) This slide shows the ballast train going out with the cooling car behind it. It doesn't do justice to Joe Ferrin's special ballast doors but I'm sure most of you have heard about them.

(Slide) This is a Mannix undertrack sled going in under the track preparatory to making the lift to bring the ballast back underneath the tie. We had some preliminary redesign problems associated with getting the sled ready because of the additional weight of concrete ties. We spent a few days getting it worked out on the ground and we finally did get it resolved. We are picking up considerably more, as you can well imagine, with each of those ties weighing 750 lb. more than the sled had been operated under before.

(Slide) That is another view of the sled with the ties up in the air. I can assure you it has no difficulty at all making the lift.

(Slide) That's one of our tampers. I can't quite figure out why it is sitting right there in the muddy road crossing doing all that tamping but someone must have had some reason for taking that photograph.

(Slide) That's the early start of our lining operation. If you will look carefully in the background you will see we are about three-quarters of a mile away from the plant. Those are two of

the three 750-foot high stacks that will be a part of that Navajo power plant.

(Slide) There is another photograph of some finished track that we had made preliminary passes with the regulator. The ditches and the parallel maintenance road have yet to be finished.

The catenary construction

(Slide) This is part of the operation we have just started on our catenary construction. This is a rather high, large, pole-hole digger using an 18 and 24-inch auger, Hy-Rail mounted, to install our catenary poles. This particular rig will actually dig into rock and we have seen it, not fast, but it does dig rock with the augers they have.

(Slide) That is a front view of the same rig. We took particular pride in making sure we put that plywood up alongside of that building augur so we didn't cast all this dirt up in the Cat house.

(Slide) This is a truck erecting the pole.

(Slide) We used standard gauge, working off the track center line of gauge, to set the poles from 10 foot per center line of track.

(Slide) A few of the poles just going up. Now in this particular area we have five cross guide poles with cross guides across the curve spanning over the maintenance road and it will pick up the cross tie on the opposite side.

This is some of the stringing equipment. It is truck-mounted on the supply truck with a push car in combination with the jumbo allowing it to set the cross-arms and to string the carrier.

(Slide) This is a similar photo. However it does show the counterweight for constant tensioning on the right-hand side of the photograph. That will keep the catenary and the messenger all in constant tension during the summer and winter.

(Slide) Little bolts that we used to get up and hang the hangers, keep the catenary and messenger separated.

(Slide) That's the configuration of the catenary system. It happens to be called the Kram-J system that we developed at Iaco. It's fairly unique, real light, and provides some real-low-line impedances which is highly necessary for your 50 kv breakthrough.

I think that is all. Gentlemen, I hope you have a little better understanding of the Black Mesa & Lake Powell, what we're trying to do out there. We certainly welcome any and all of you to come and visit with us and if you would really like to, you can see me after the program or make some contact with me in San Francisco. Thank you for allowing me to be here. (Applause)

President Fuller: Thank you, Jim. We certainly appreciate your coming because this has been a very fabulous project, with many unique problems to solve. Again, Thanks. Roy.

President Gunderson: Mr. Pearce, I can't help but wonder, as I watched that film, when do you start taking applications for the track supervisor's job on that railway? That's about as close to Utopia as anyone will ever get.

Introduction of G. M. Leilich

Now I could be accused of having too much to say this morning but I consider it a personal favor to be allowed to introduce our next speaker. This young man, I'm increasingly convinced that youth is purely relative, was born in Milwaukee, Wisconsin, in 1916. He received his Bachelor of Science degree in Mechanical Engineering at Purdue.

His graduate work was a Strasonite Fellow in Transportation at Yale.

His railroad career started on the Lehigh Valley as a special apprentice in motive power. He missed very few headquarter locations on that railroad as he advanced from assistant trainmaster to superintendent.

He joined the Western Maryland Railway Company as general superintendent in 1953 and was advanced to vice president of operations in 1955,

the position he now holds. He also is a director of our Western Maryland Railway Company.

Now he, too, is happily married and his wife Doris, is also very charming. They have two sons, both married, and he's referred to as grandfather in some circles.

He, too, belongs to many clubs, professional societies, and community organizations, usually being president or chairman. He travels a great deal. He is a skilled photographer and has many varied interests, but his principal one, I believe, is railroading.

He is a Past President of our related Superintendents' Association. I have worked very closely with him for years. I respect him as a boss and as a friend.

He is eminently well qualified to speak to us on his selected subject. I am really proud to present George M. Leilich, vice president of operations for Western Maryland Railway Company.

Safety Is No Accident

By G. M. Leilich

Vice President-Operations, Western Maryland

Thank you, Roy. You know, Mr. Pearce, we didn't have the glamor that you had in connection with handling a new railroad, but we did haul a box car down a highway for 12 miles and if you don't think that didn't create an interest, you're wrong. People came running out of their houses and said, "Look what's coming down the highway." This was an aftermath of Agnes.

Now my boss who preceded me here this morning said I was up in Canada during Agnes. That's correct. And there is one more casualty that relates to Agnes that he didn't mention. My wife had the divorce papers all made out after I was told—after it was suggested that I come back from my vacation because all the help that was available was required and I was part of that that was considered available. So we brought our trailer some 1300 miles and I think the last 800 miles there were no words exchanged between us. (Laughter) I guess you as railroad men can appreciate that.

There is a sign in a nudist camp outside of London, "Where Men and Women Come to Air their Differences". You here, at the Roadmasters' Association Convention, could post a somewhat similar sign in that it is here that you will air your differences.

Having worked in the field of railroading for over 35 years, I appreciate the laws of physics may be applicable to all sections of the country, but the application of those laws and the understanding of those laws differ on different properties.

Just 12 years ago this very day, I addressed your companion organization, the American Railway Bridge & Building Association, of which your present President was then its President. It is my understanding that this is the first occasion that the same individual has served as President of both

these organizations over a period of time. I am proud of the fact that a Western Maryland man can claim to be first. Knowing Roy as I do, I believe that he certainly merits the confidence that this honor expresses.

Twelve years ago, the subject of my address was, "Safety is No Accident". It is fitting that the subject of my address here today be the same. Perhaps it should be "freshened" up a bit to, "Those who put safety-first, last". Knowing that all of you have excellent memories, and that some of you did attend that convention, I would not dare risk repeating what I said during that address, for fear of boring you with repetition. However, a brief reference to it would seem appropriate in somewhat of an outline form.

The general theme of my address on that occasion was the importance of off-job safety and that, not only is safety at work of national concern, but that safety "unqualified", is of national concern. It was pointed out that high employee morale means, not only production efficiency, but a high standard of safety performance. Ninety-five per cent of the unsafe acts committed do not result in an accident or injury. To reverse this statement, each accident is but 5% of the time that a particular employee has, in effect, asked for an accident. The concluding part of my discussion in 1960 was the description of an average accident statistic—its predictability by craft, nature, time, day of the week and so forth.

Today, I shall have a somewhat different emphasis, than upon that prior occasion. First of all, I would like to comment upon the question of how we can measure the effectiveness of a particular safety program or effort on any of our properties. In that regard, I would refer to an article by H. Gene Miller, Director of Statistics Division of the National Safety Council, who addressed this very topic in an article published in *The National Safety News* of October, 1953. I would like to extract a few of his comments and suggestions from that article in the next few remarks that I would present to you:

G. M. Leilich

"Contrary to general opinion, injury frequency rates ordinarily do not provide an accurate evaluation of the safety program.

In addition, changes in injury rates—increases and decreases—do not necessarily indicate similar changes, either in direction or in amount, in the level of the program."

Mr. Miller pointed out that the total number of injuries during a period of time will, of course, be related to the general level of the safety program, but the occurrence of particular injuries will be subject to a variety of circumstances which can be summed up in one word "chance". At the same time, he emphasized that the variation in number of injuries may indicate a change in the level of the safety program and then proceeded to discuss how to distinguish whether the variation is due to chance or a change in the program.

The statistical approach

The essence of his article was a statistical approach to evaluate changes

or variations in the given number of injuries to determine the parameters indicated by those caused by chance and those caused by something other than chance. The statistical procedure, and I shall be brief, involves the establishing of a unit of variation, that being the square root of the number of injuries. If the normal number of injuries during a certain period of time is 100, then the unit of variation is the square root of 100 or 10. It has been established that two units cover most of the variation that can occur due to chance. Therefore, the range of chance variation around the normal or average number is determined by multiplying this unit of variation by 2. Thus, in our example of the normal injuries of a period being 100, chance could be involved in the variation between 80 and 120. In other words, there is a standard deviation of $\pm$ 20. So much for statistics, however, I think they are important to understand lest we put too much emphasis upon a small statistical change in what is occurring in our performance.

Let's speak a little now about the psychology involved in safety performance, as I think this is the very root of the safety effort. Alvin Toffler wrote a book two years ago entitled, *Future Shock*. If you have not read this, I would certainly recommend it to you. The theme of his book is the fact that the rate of change has so greatly increased in our society that we are being subjected to what he labels "future shock." He defines future shock as, "the dizzying or disorientation brought on by the premature arrival of the future. It may well be the most important disease of tomorrow."

Future shock is the response to overstimulation. It occurs when the individual is forced to operate above his adaptive range. Considerable research has been devoted to studying the impact of inadequate change and novelty on human performance (such as on auto assembly lines). Studies of men in isolated Antarctic outposts, experiments in sensory deprivation, investigations into on-the-job performance in factories, all show a falling off of mental and physical abilities in response to understimulation. We have less direct data on the impact of overstimulation, but such evidence as does exist is dramatic and unsettling.

During World War II, a bearded Chindot soldier, fighting with General Wingate's forces behind Japanese lines in Burma, actually fell asleep while a storm of machine gun bullets splattered around him. Subsequently, an investigation revealed that this soldier was not merely reacting to physical fatigue or lack of sleep, but surrendering to a sense of overpowering apathy.

It may be that, in our approach to safety within our various areas of responsibility, we must deal with a new kind of understanding which requires a different kind of an input than ten years ago or even five years ago—certainly of twenty or more years ago. In that regard, I would suggest a few questions which I consider somewhat provocative.

For example, all of us have gotten on the hard hat bandwagon. It seems to me that there are many locations where hard hats are required solely for the psychology of trying to make the employee aware of safety, rather than the actual need. Today's worker is much more sophisticated than yesterday's worker. He hates busy work; he dislikes paternalism and, certainly, he does not like to be given orders to be required to do something which serves no useful purpose in itself. Does it not do more harm by discrediting the real need for perhaps other safety habits, where no real head threat is involved? For example, why should it be required to wear hard hats in an engineering office? Should we not custom design our safety regulations to a greater extent than in the past?

Accidents from negligence

Last year, the National Transporta-

tion Board listed transportation safety's ten worst enemies. At the top of the list was alcohol. This is one area where, in 1972, there must be a better approach than the simple, traumatic approach of Rule G. Just last week the National Transportation Safety Board proposed a thorough analysis of the factors that have caused a large number of railroad accidents to be attributed to employee negligence.

The Federal Railroad Administration and the Interstate Commerce Commission have classified almost one-third of more than 60,000 train accidents — about half of the 357 deaths and 8,500 injuries—in the past decade as the result of "negligence of employees."

The safety board said the FRA should investigate possible inadequacies in operating rules and practices, in instruction or enforcement, and in equipment design or maintenance.

"It is easy to dismiss an accident as resulting from an employee's negligence when, in fact, the accident may have resulted from the failure of the system," the board said. The safety board said its own study of the FRA and ICC accident investigation reports showed some correlation between the economic condition of the railroad and the frequency of accidents attributed to employee negligence.

The board said statistics for 1968 and 1969 indicated that the more prosperous railroads had an accident rate below the national average for all accidents, including those attributed to employee negligence.

"It is probable that the employees on the more prosperous railroads have better and more modern tools with which to perform their duties, and that their supervisors spend more time to assure that employees perform their duties safely," the board said.

The Occupational Safety & Health Act of 1970 is now effective, to an extent, within our industry. I am sure its impact and influence will spread so we have a new input for supervisory management to consider in its relation with its employees. As you know, a clarification has been issued distinguishing those areas that come under the specific jurisdiction of the Department of Transportation and those that come under OSHA. It can be generalized by saying that those operations peculiar to railroad continue under the DOT; those which are common to all types of industries such as office work come under the OSHA regulations.

We must recognize changes

I would raise another question which has been raised in connection with other disciplines that have found their place among the railroad organizational charts and that is the question raised by John Gardner, then Secretary of Health, Education & Welfare, in his article involving the problems of organization, and I quote:

"Most organizations have a structure that was designed to solve problems that no longer exist."

I am not inferring that the problem of safety does not exist, but I am suggesting that perhaps our manner of dealing with it should change to recognize some of the earlier facets of change in our whole sociology and in our whole environment, our level of education, our degree of sophistication and so forth. I will enlarge upon that theme as I continue with my comments.

"What does man gain by all the toil
at which he toils under the sun?
A generation goes, and a generation
comes, but the earth remains forever.
The sun rises and the sun goes down,
and hastens to the place where it
rises.
The wind blows to the south,
and goes round to the north;
round and round goes the wind,
and on its circuits the wind returns.
All streams run to the sea,
but the sea is not full;
to the place where the streams flow,
there they flow again.
What has been is what will be,

and what has been done is what will be done;
And there is nothing new under the sun."

This pessimistic philosophy of life by an ancient thinker might be paraphrased to reflect the thinking of some people regarding safety. It seems the more we struggle with the problem of accident prevention the more there is to do. As the Pennsylvania Dutch put it, "The hurrier I go the behinder I get".

To state that we have a problem is almost redundant. Accidental deaths and unnecessary injuries are like a plague—affecting all ages and all strata of society. I'm not going to bore you with a mountain of figures but it's shocking to note in the National Safety Council's latest edition of *Accident Facts* that:

1. 114,000 persons lost their lives accidentally in 1970 and another 10,-800,000 suffered disabling injuries. (ibid. p. 3)
2. More than 1,000 persons a week are killed on our streets and highways—55,000 each year. (ibid. pg. 3)
3. Nearly twice as many people lost their lives accidentally at home as at work. (ibid pg. 3)
4. We see that our kids receive the best of medical care but a tragic fact is that for children 1 to 14 years of age, accidents claim more lives than the six leading diseases combined. (ibid. pg. 9)
5. Among young people ages 15 to 24, accidents take more lives than all other causes combined. And four out of five victims in this age group are boys. (ibid. pg.)

My purpose in mentioning these facts is to emphasize the all pervasive impact of accidents on our lives. Could it be that living daily in such an atmosphere, we become inured to the seriousness of it? Is this why we find it so difficult to understand why our people are injured when we try to provide safe working conditions, emphasize safety and stress compliance with Safety Rules.

In short, is safety a matter of logic? My observation is that it is not. We, all of us, simply are not consistently logical. Even if we can be shown that a given course of action will benefit us, we will not always accept and follow it. For example, all of you here are vitally concerned with safety and health. Yet, how many of you are users of cigarettes in spite of the printed warning on every cigarette pack and in every cigarette advertisement stating, "The Surgeon General has determined that cigarette smoking is dangerous to your health?"

Another example—Have you formed the habit of always using your seat belt and insist that your passengers do likewise? A recent saturation campaign of television commercials urging seat belt use "had no effect whatsoever", reports its sponsor.

Make seat-belt survey

During a nine month period in 1971 and early 1972, the insurance Institute for Highway Safety conducted a television campaign in a middle-sized American city consisting of six professionally produced commercials. Observations were made of cars throughout the city to determine any change in the level of seat belt use.

At the end of the period, the researchers discovered that the campaign has been a complete bust. In fact, seat belt usage actually declined, but this was believed due to the onset of cold weather and the inconvenience of buckling belts over winter clothing.

"In spite of the number of campaigns urging safety belt use," concludes the institute, "the proportion of vehicle occupants using them is so low that much of the reduction in death and injury that should be achieved by their use is not being realized."

I was amused and impressed by how quickly our company chauffeur circumvented the 1973 auto seat belt installa-

tion. I have heard of how dealers were conspiring with their customers on how to cut out the circuitry which requires the seat belt to be buckled when the ignition is on to quiet a buzzer. He simply buckled it once and for all, and then sat upon it when driving.

How much of a reduction is not being realized? The Highway Safety Foundation estimates that half of the 50,000-plus deaths recorded in the nation every year could be prevented if people would wear their seat belts. Disabling accidents could be cut by 25 per cent.

With this attitude so prevalent we should not be surprised that most of our injuries and deaths are the result of carelessness and unconcern.

Another safety philosophy I have observed closely deals with one's attitude toward safety rules. I sincerely believe supervisors must display a respect for safety rules themselves and insist that their people put them into practice. How do we accomplish this goal? Well, certainly, the supervisor must thoroughly understand the rules and be convinced the "right" way is the only way to do the job. The other side of the coin is the employee must be trained to perform his work according to established company policy. Too often the extent of training of new employees is limited to the work habits, both good and bad, of older employees. Real training occurs only when you are able to create a desire in a person to want to perform in a given way. But training must not be restricted to new employees. Training and education should be a continuous process for all employees, supervisors included.

Closely related to this point is enforcement of safety rules. It is my feeling safety rules need to receive the same type of respect and enforcement that most of us reserve for operating rules. But I have come to the conclusion that punitive efforts have their limitations. I believe training to be a far more effective motivator than punishment. Even the United States Army, with nearly 200 year experience, has come to realize this philosophy and are stressing training and de-emphasizing punishment.

Another area currently in the safety limelight is the work site and the condition of tools and machinery used. The Occupational Safety & Health Act will, no doubt, produce some very meaningful progress in job safety. Uniform standards and enforcement on a national basis is surely a plus in the field of safety.

Safety lies with individual

May I suggest, however, that while work environment and safe equipment are important, the primary area for safety improvement lies with the individual. After all the safeguards have been engineered into a machine, its ultimate safe use rests with the user. Any device, no matter how safe or simple, can be a potential hazard, if used without judgment or caution. For example, I'm certain all of us favor the efforts being made to produce safer automobiles, yet the driver is the greatest hazard to highway safety. Of the 16,000,000 auto accidents in 1970, the latest year for which a detailed analysis of figures is available, improper driving was the cause of 92.7% of the accidents. Think of it—on only 7.3% of the auto accidents was the driver blameless. (ibid. pg. 40, 48) Safer autos? Yes—safer drivers?—Imperative.

I am convinced that slogans, cliches, gimmicks and platitudes have a very minimal effect on a person's attitude toward safety. I believe the most effective way to influence a person's safety awareness is on a one to one basis. The first line supervisor must display a persistent, dedicated, conscientious interest in the safety of each of his people. There is no glamorous short cut to injury prevention but to the sincere supervisor, the inner satisfaction of seeing his people head for home at the end of a work day safe and

sound is ample reward for all his efforts.

Many more years ago than I now like to admit I chose railroading as a career. My enthusiasm has not dimmed, nor has my faith in our industry. Most of us will leave very faint footprints upon the sands of time. All of us, however, have the opportunity to contribute, in some manner, our talent and time to the cause of safety. In this way, we can truly say the world was just a bit better because we walked this way. What will your contribution be?

President Gunderson: Mr. Leilich, we all thank you very sincerely for taking time to be with us today. Your message is timely and pertinent for each one of us and I feel that we are concluding this meeting this morning in a rather thought-provoking manner. Thank you so much for being with us.

I call attention again to the Annual Banquet that will be held in the Grand Ballroom of this hotel this evening.

Now your paid-up dues will be your identification to receive complimentary tickets from REMSA for both you and your lady. If you have not already done so, check with the REMSA desk in the registration room and I am sure that that detail can be handled very easily.

I was going to acknowledge the presence of my counterpart from the Western Maryland Railway Company; the mechanical people are having a meeting concurrent with this one in another hotel around here and our Chief Mechanical Officer, Jim Shubers, and one of his assistants was sitting in the audience. I'm sure he wasn't here just because Mr. Coliton and Mr. Leilich were on the program this morning. I suspect he was here primarily to find out how things are done over in this area.

I don't have the latest figure on registration this morning. Unless there is any further business to come before us at this time, and there is none appearing, I declare this session adjourned.

. . . Recessed at 11:35 A.M. . .

Steel Protective Coatings

Committee Report

COMMITTEE—W. R. Hyma, *Chairman*, br.engr.sys., A.T.& S.F., Chicago; R. C. Force, *Vice Chairman*, b.& b. supvr., L.& N., Lafayette, Ind.; G. A. Tieman, *Vice Chairman*, des., I.C., Chicago; L. D. Davis, sls.mgr., BASF Wyandotte, Mich.; J. W. DeValle, ch.engr.br., Sou., Atlanta, Ga.; J. C. Hobbs, engr.trk.& struct., R.F.& P., Richmond, Va.; J. T. Johnson, gen.supvr.b.& b., L.& N., Louisville, Ky.; J. A. Jorlett, struc.engr.(ret.), P.C., Harvey Cedars, N.J.; P. F. McCartan, asst.ch.clk., I.C., Chicago; J. L. Mathieu, dftsn., I.C., Chicago; E. F. Runde, mgr. const., I.C., Chicago; W. M. Russell, br. insp., I.C., Chicago; J. F. Schmitz, b.& b.supt., M.P., Little Rock, Ark.; and J. M. Williams, supvr.b.& b., E.J.& E., Gary, Ind.

I—RESULTS OF QUESTIONNAIRE

A—General

To develop the background information needed for the preparation of this report, your committee sent a questionaire to 39 railroads in the United States and Canada. Replies were received from 28 which gave a comprehensive review of the current painting practices throughout the industry, and pointed out some topics of special interest.

Faced with more or less common problems in construction and maintenance of both track and structures, the various railroads usually develop fairly uniform procedures, modified as

needed to meet their own special requirements. Generally, personnel on each railroad are convinced that their own practcies and modifications are the best for their circumstances. Thus, it it interesting that, of the 28 roads responding to the questionnaire, only four indicated that they were satisfied with their present painting practices and two of these qualified their satisfaction by noting a need for more painters and more equipment. In addition to the need for more manpower and equipment, most of the respondents expressed a desire for better paints and better methods of surface preparation. Several referred to deficiencies in supervision and inspection as part of their painting problems.

W. R. Hyma

B—New structures

To further summarize the information gathered from the questionnaire, only six replies indicated a preference for concrete spans and only three stated that unpainted high-strength, low-alloy "weathering" steel was being used for a majority of new bridges, which is somewhat surprising in light of the dissatisfaction with painting procedures.

A majority of the railroads do not have specifications of their own for surface preparation and painting of new work, but over 80 per cent indicated use of the Steel Structures Painting Council (SSPC) Specifications. Without exception, all stated that they accept State Highway Specifications for painting on grade separation projects. Perhaps following the trend of the highway departments, approximately half of the railroads replying to the questionnaire are now calling for blast cleaning prior to shop painting on new work.

No pretreatment wash coats are being specified and red lead and linseed oil, with and without alkyd resins, is still the most popular primer although there is some use of vinyls, zinc rich, lead sub-oxide, zinc chromate, and red lead-iron oxide shop coats for new work. Again reflecting the fact that the majority of new spans are in grade separation projects initiated by highway agencies, leafing-type aluminum alkyd top coats are most frequently specified, but there is some use of black graphite or lead sub-oxide oil-base finish coats. Several roads also indicated some use of vinyls and epoxies for special conditions. In this regard, only seven replies indicated that the paint system specified for new work was varied to suit the anticipated exposure.

Field painting of new structures is being done both by contract and by company forces, probably depending on whether the work is being paid for by outside agencies or the railroad. In either case, almost all of the painting is by spray, either air or airless. Most shop inspection is done by contract or by other agencies, with contract field painting regularly inspected by company personnel for only eleven of the railroads. In very few cases of company inspection is the mil thickness of the paint coating checked either wet or dry.

C—Existing structures

Nearly all of the repainting of existing bridges is done by company forces

and only six of the roads reported that they had formal standard specifications covering maintenance painting. No cost figures were submitted for maintenance painting, although this probably reflects the difficulty of defining units rather than a complete lack of cost data.

Hand-tool and power-tool cleaning were the most common forms of surface preparation reported for maintenance painting, although the fact that approximately half of the replies indicated the use of blast cleaning was somewhat unexpected. Spot priming with a complete finish coat was the most common practice, although a complete prime coat, evidently in conjunction with blast cleaning, was frequently reported. Two roads reported the use of rust-inhibitive greases as standard maintenance practice, two stated that no painting at all was done in rural environments, and five indicated the use of proprietary one-coat, lead sub-oxide, formulation. In very few instances was there an indication that the system was varied to suit the particular environment. Similary, there is little formal inspection of maintenance painting other than by B.& B. supervisory personnel, and this inspection seldom includes a check of mil thickness. Less than 25% of those reporting stated that they restricted painting to set limits of minimum temperature or maximum humidity with the majority relying on the judgement of the foreman to determine if atmospheric conditions are suitable for painting at the time.

The normal maintenance painting cycle varied widely with a reported minimum of 5 years between paintings ranging on up to a maximum of 20 years. The usual average cycle was stated to be between 9 and 14 years. The cyclic interval did not seem to follow any geographical pattern, nor was it possible to establish a valid relationship between the cycle and the application procedures or the materials used on the job.

II—SURFACE PREPARATION

With many of the new paint systems requiring a blast-cleaned surface, and with a significant number of the responding railroads reporting the use of blast cleaning as the preferred method of surface preparation both for new work and for maintenance repainting, your committee felt that some information should be presented on this subject.

For new work, the blast cleaning will usually be done in the shop as more and more fabricators are installing the necessary equipment. The degree of cleaning should be in accordance with applicable SSPC Specifications including No. 5 White Metal Blast Cleaning. No. 10 Near-White Blast Cleaning, No. 6 Commercial Blast to be done in the field, No. 9 Weathering Followed by Blast Cleannig may be used. Commercial blast cleaning will suffice for most paint systems, but in all cases, the grade of cleaning should comply with the requirements of the paint system specified or the recommendations of the paint manufacturer. The degree of cleaning under each grade specified is subject to interpretation and can often be a matter of dispute. For this reason, visual references such as SSPC-Vis 1 or time rate control standards may be incorporated into the specifications, and it may also be prudent to include arbitration procedures.

Current research indicates that the profile between peaks and valleys on the surface may be one of the most important variables influencing paint performance, and the application directions for the newer coatings often refer to this anchor pattern. While the SSPC Blast Cleaning Specifications limit the size of abrasive particles to be used, and include directions for measuring profile by grinding and using a micrometer depth gauge, a more practical method for an inspector is by means of a pocket-size surface-profile comparator developed by SSPC and available from that organization for $60.

For maintenance work, the success and economy of sandblasting is largely dependent upon proper equipment and the best advice in this regard is to think big. Production varies according to the nozzle diameter, the air pressure and the air volume. A ½-inch diameter nozzle will clean four times the area per minute that can be cleaned with a ¼-inch nozzle, and will require four times as much air and sand in the process. Air pressure should be in the 90 to 100-psi range at the nozzle and efficiency will decrease about 1.5% for every 1 lb decrease in pressure, so all hoses and fittings must be of adequate size. Based on the experience of several railroads, the following steps are recommended in assembling equipment for a sandblast operation.

Select an adequate compressor. A unit capable of delivering 350 cfm at 120 psi is the minimum for use with a ½-inch nozzle, and this size will usually provide maximum efficiency. A ⅜-inch nozzle requires 210 cfm and a ¼-inch needs at least 125 cfm. If nozzles are allowed to wear excessively, even these compressors may be inadequate. The compressor will run constantly during blasting so should be of the rotary-screw type to provide a constant volume of oil-free, low temperature air with minimum maintenance. Handling this size compressor may be a problem, particularly for a paint gang. The choice between truck mounting, skid or trailer mounting, or rail mounting with set-off equipment will depend on site accessibility, track availability, and handling equipment.

Use at least 1¼-inch I.D. hose between the compressor and the sandblast machine, and keep the length to a minimum. If site conditions require considerable separation, large diameter pipe can be used to minimize pressure losses.

Select a lightweight portable sandblast machine mounted on wheels and meeting A.S.M.E. Code requirements. A 600-lb capacity machine will provide for 20 to 30 minutes of operation between fillings. The machine should be of the gravity-flow direct-pressure type with 1¼-inch piping, concave head, automatic filling valve, adjustable abrasive carburetor valve, separate inlet and outlet valves, and moisture separator.

Use a 1¼-inch I.D. static-dissipating sandblast hose with external quick-connect couplings and flanged nozzle holder. Short whips of ¾ of 1-inch dia. hose may be necessary for some locations, but should be avoided when possible to minimize the pressure drop at the nozzle.

Provide remote control deadman valves in all cases so that release by the operator will provide instant shutdown and depressurization of the machine.

Use Venturi-style tungsten-carbide lined nozzles with 1 or 1¼-inch entrance opening. The long nozzle is faster but the short style provides maximum accessibility in close quarters. A variety of sizes and lengths is advisable to suit all conditions.

Equip the operator with a Bureau of Mines Approved air-fed, hard-hat helmet with expendable plastic lenses, and with a belt and break valve. To minimize downtime when changing operators, two helmets can be provided. Air conditioning units are available for the air supply to the helmets. Leather gloves and aprons should be provided for the operator, and goggles are needed for the entire crew.

Since production will depend on the adequacy of the scaffolding, crane-mounted platforms or personnel baskets, power staging, or rolling scaffolds may all be justified. Portable lighting is needed when working inside deck-girder spans.

The cost of equipment described, without the compressor, scaffolding or lighting, will be approximately $1800.

The proper abrasive to be used depends on the condition of the surface to be cleaned, and the surface profile desired. High grade silica sand of the Ottawa type passing a 16-mesh screen,

U.S. sieve series, is commonly used. One road reports using a No. 35 crushed silica grit to remove grease coatings from surfaces to be painted. In all cases, the use of bagged abrasives is recommended to eliminate field drying waste, and delays encountered in handling bulk materials. The cost of sand in 100-lb. bags is usually about $8 to $10 per ton, and consumption will average about 1500 lb per hr with a ½-inch nozzle.

The total cost of sandblasting is very difficult to predict since there are many variables including types and condition of surface, degree of cleaning, etc., but the usual range for brush-off blast cleaning should be from 10 to 30 cents per sq. ft.

Adequate training of personnel is important in achieving the desired results with maximum economy. Various manufacturers of blast-cleaning equipment have some very good literature describing cost - saving techniques. Some 16-mm colored movie films illustrating recommended procedures are also available from at least one manufacturer.

III—COATINGS

In the past few years, there has been a tremendous proliferation of materials designed to protect steel surfaces from corrosion, including vinyls, epoxies, silicone-alkyds, urethanes, chlorinated rubbers, coal tar epoxies, and zinc rich paints. To illustrate the problem facing anyone trying to make a choice from these newer formulations, zinc rich paints can be classified as organic and inorganic. The organic type can have a vehicle of chlorinated rubber, polystyrene, epoxy esters, catalyzed polyamid or amine esters, polyesters, urethanes, acrylics, vinyls, silicones, or many variations within each class. Similarly, inorganic zinc rich paints can be silicates, silicate esters, zinc-lead silicates, phosphates, and modifications thereof. To further compound the problem, there are well over 100 different companies manufacturing and marketing these zinc rich paints. Obviously the choice becomes a difficult one and just as obviously, it is beyond the scope of this assignment or the expertise of your committee to attempt an evaluation of these newer coatings in anything but a very general manner.

Fortunately, a great deal of help is available through the research and publications of the Steel Structures Painting Council (SSPC) which is composed of representatives from coating manufacturers, steel fabricators, using organizations, and various technical associations. The Association of American Railroads at one time was a supporting member of the Council and railroad representatives played an important role in the formation of the Council in 1950 and in the preparation of the Steel Structures Painting Manuals, Volume 1-*Good Painting Practice* and Volume 2-*Systems and Specifications.*

The AAR, the AREA, and the ARB& BA still maintain technical liaison with the SSPC, and several individual railroads are patron members of the Council.

Every railroad supervisor involved in the painting of steel structures should be on the mailing list of the SSPC which can be accomplished by writing: Steel Structures Painting Council, 4400 Fifth Avenue, Pittsburgh, Pa. 15213. The painting bulletins, which will then be received periodically from SSPC, will list all publications and special reports available from the Council.

Most of the current research related to bridge painting is aimed primarily at highway problems, but the findings are applicable to railroad work as well, with the possible exception that highway practice puts a greater emphasis on appearance. A study made by the SSPC staff under the sponsorship of the Bureau of Public Roads and the American Association of State Highway Officials and published in 1969 by the Highway Research Board of the National Academy of Sciences under the

title "Protective Coatings for Highway Structural Steel" is available from SSPC and is a very comprehensive review of the current literature and the current practices of various highway agencies. Recommendations are based on an evaluation of more than 4000 paint-exposure tests including panel tests at Pennsylvania, N. Carolina, California, Bermuda, and Canadian sites; a number of railroad sites tested previously; and at several major highway bridges in connection with a continuing study for the International Bridge, Tunnel and Turnpike Association.

The most interesting portions of this highway report are those containing specific recommendations for coatings to be used in certain environments or zones.

Six different zones are defined as listed:

1A—Interior, normally dry
1B—Exterior, normally dry
2A—Exterior, frequently wet by fresh water
2B—Exterior frequently wet by salt water
3 —Chemical exposures—acid, alkaline, oxidizing, solvents
4 —Special, galvanized, mildew, welds, temporary

All of these exposures are found in railroad practice and, except for 1A, all zones can sometimes exist in one bridge structure.

The preferred coating system for each zone is summarized as follows:
1A . . . One coat of fast-drying shop paint such as SSPC No. 13 which is an iron oxide pigment in a tung oil-ester gum varnish vehicle with linseed oil added. Surface preparation is nominal hand cleaning. A compatible finish coat for appearance is optional.

1B . . . Two coats of oil-base primer such as SSPC No. 14 which is a red lead-iron oxide pigment in a linseed oil vehicle followed by 1 or 2 finish coats of a long oil alkyd paint such as SSPC No. 101 which is a leafing or non-leafing aluminium alkyd, or SSPC No. 104 which is a white or tinted alkyd. Dry thickness should total at least 4 mils for 4 coats. Surface preparation should be thorough hand of power-tool cleaning, although the recommendation states that longer life will be obtained from blast cleaning.

2A . . . Four coats of vinyl paint such as SSPC No. 9 which is a ready-mixed white or tinted vinyl chloride-acetate copolymer paint making up SSPC Paint System 4.04. SSPC No. 8 which is an aluminum vinyl can be substituted for an alternate finish coat. Thickness of the first coat should be at least 1.2 mils and for the four coats should total not less than 4.5 mils. Surface preparation should be a near-white blast clean surface rather than the commercial blast surface specified in SSPC-PS 4.04.

2B . . . One coat of an approved zinc-rich paint such as those on the qualified product list of military specification MIL-P-23236 or California Highway Department Specification 66-G-55 with a thickness of at least 2.5 mils. (The SSPC-PS 12.0 is a guide to the use of zinc-rich coatings, and performance specifications for both organic and inorganic zinc-rich paints and paint systems are now in draft form and will be released in the near future.) After the specified weathering period, a 0.3 to 0.5 mil wash coat of vinyl wash primer such as MIL-P-15328 or SSPC-PT-3 should be applied followed by 3 or more mils of the approved vinyl finish coat such as SSPC No. 8, 9, or VR3, or Calif. Vinyl 67-G-75. There is considerable danger of incompatibility between the zinc-rich paint and the finish coat so no combination should be used without the manufacturer's recommendation and/or proven test performance. Alternate finish coats suitable for this zone include epoxies, chlorinated rubbers, or coal tar epoxies. In all cases, surface preparation should be blast cleaning to near-white metal and, with some coatings, to white metal. Since the performance of some zinc-rich paints is very dependent on the surface profile or degree of roughness, the

manufacturer's instructions in this regard should be followed closely.

3 . . . The recommendations for Zone 3-Chemical exposures are the same as for Zone 2B except the finish coat should be chosen to withstand the particular chemical environment. Coal-tar epoxies have a wide range of chemical resistance; vinyls are effective against acid and alkali salts; and epoxies resist gasoline, oils, salt brine, alkalis, fats, some non-concentrated mineral acids, and most solvents. The necessity of assuring compatibility between coats is emphasized.

4 . . . The varieties of special conditions are too broad to be covered here except for the matter of painting welds. Here it is recommended that a 2-inch strip be left unpainted before welding and that the area be blast cleaned after welding and before painting. A less desirable alternative is to chip and wire brush the weld area thoroughly and to wash with 50% phosphoric acid, rinse, and dry before painting.

In all the recommendations, there is a necessity for checking mil thickness and, in fact, the thickness of the paint film is often more important than the type of coating selected. Checking wet mil thickness allows for prompt and inexpensive corrections but must be done immediately after application as the evaporation of volatile solvents will cause significant changes in a matter of seconds. Roll or prong gages are most commonly used to check wet thickness. While the roll gage may be more accurate, the prong gage is cheaper and simpler. A number of devices are available to check dry mil thickness with the two most common being the Elcometer and the Mikrotest, both of which work on the basis of electromagnetic induction. While reasonably accurate, both must be used carefully and in close accordance with instructions if reproducible, consistent measurements are to be obtained. If it becomes necessary to establish the thickness of various coats in a total paint film, the Tooke scratch gage is the most practical tool. This gage operates by cutting the film at a pre-set angle, and magnifying the beveled edge for comparison with a calibrated scale viewed in the eyepiece.

Most railway bridges fall into Zone 1B, and the most prevalent railroad painting practices using oil-base prime and finish coats are in accord with the recommendations for this zone. Results of earlier tests by various railroads in cooperation with the SSPC and reported by the SSPC have shown the effectiveness of this paint system. These tests are covered by Special Report 52 —"Painting Steel Bridges for Mild Exposures", SR 53—"Protecting Load Bearing Surfaces of Bridges", and SR 54—"Weathering of Structural Steel Before Painting", all of which are currently available from SSPC.

Several roads have reported using a ready-mixed organic zinc-rich coating in a rubber base vehicle protected with a two-component, catalyzed polyamid epoxy finish coat for certain special applications.

One of these special installations involved the coating of steel H-piles prior to driving in soil where it was feared extensive ground-line corrosion would occur. A 10-ft section was sandblasted to a near-white surface and coated in order to protect the first five feet in the ground and provide for a five foot variation in driving. Costs were approximately $1.00 per square foot, including 28 cents for material and 72 cents for labor.

Another road used the same materials for a similar installation with 14-inch dia. steel pipe piles but omitted the sandblast, applying the zinc-rich primer to a wire-brushed surface. A recent inspection showed the coating to be in excellent condition after three year's service.

Another use of the same zinc-rich primer and epoxy top coat was to paint the top flanges of a deck-girder span before the solid timber ballasted deck was placed, and in this case, the surface was sandblasted. The prime coat

dried in 4 to 6 hours and the epoxy top coat was dry to the touch in four hours, which limits the application in a deck renewal to those locations where the track can be kept out of service for a sufficient length of time.

Several different roads report the use of a self-priming one-coat system of maintenance painting utilizing lead sub-oxide pigments in a linseed-tung oil vehicle reinforced with synthetic resins. Brush-off blast cleaning is recommended although the oil vehicle has good penetrating and wetting properties and satisfactory performance over hand-cleaned surfaces has been reported.

The coating is applied by airless spray to a wet thickness of 8 to 10 mils to give a minimum dry thickness of 6 mils. The coating is extremely slow drying and cures by a chemical reaction between the vehicle and pigment which produces first a lead soap and finally a metallic lead film which ages by erosion, leaving a repaintable surface. Case histories going back 20 years in various applications on several railroads indicate good results in a variety of environments.

In summary, it appears that the best and most economical program should be based on a zone system, tailoring the surface preparation and painting to the particular exposure. Prior inspection at each location is required to evaluate the conditions and establish the action to be taken. Since surface preparation and coating thickness have proven to be as important as the proper selection of materials, adequate inspection and supervision of the application is essential if satisfactory results are to be obtained.

Weathering Steel

Committee Report

COMMITTEE—J. W. DAVIDSON, *Chairman*, asst.dir.bldg.engrg., B.N., St. Paul, Minn.; E. B. DOBRANETSKI, proj.engr., B.& L.E., Greenville, Pa.; L. D. GREEN, asso.struc.engr., S.L.-S.F., Springfield, Mo.; C. W. HARMAN, struc.engr., S.L.-S.F., Springfield, Mo.; R. C. MCMASTER, supvr. struc., B.& L.E., Greenville, Pa.; F. A. MIMICK, b.& b.supvr., U.P., Salina, Kan.; and N. N. SORENSEN, b.& b.supvr., U.P., Omaha, Nebr.

In the early 1930's, several steel companies developed high strength-low alloy steels primarily intended for use in railroad car construction. These steels offered strength 40% greater than conventional carbon steel, permitting construction of lighter-weight cars, which could be translated into greater payloads and better train performance. These cars, both passenger and freight, were painted but it was found that paint lasted much longer than on conventional steel. This discovery led to experimentation with unpainted hopper

J. W. Davidson

cars and other usages where unprotected low-alloy steel was deliberately left to weather.

Can be left unpainted

Today, the term "weathering steel" is used to designate a family of high-strength low-alloy steels having an atmosphere-corrosion resistance at least four times that of conventional carbon steel, and that can be left unpainted under most conditions. The most frequently used weathering steel is ASTM Specification A588, but other weathering steels, such as ASTM Specification A514, are also available when even higher strengths are required. While weathering steels contain only small amounts of copper, manganese, chromium and other alloying elements, this is sufficient to change the character of the rust film.

The rust film on carbon steel is scaly, loose and porous and cannot seal off the base metal against further corrosion. In weathering steels, the alloying ingredients cause the rust film to develop as a dense, tightly adherent oxide coating. This starts out as the usual orange-red rust film. Instead of becoming progressively thicker, the rust film on weathering steel remains very thin. It stays tightly attached to the parent metal, protecting it against further attack, and merely weathers to a progressively darker color with the passage of time.

Ordinarily, about two years of outdoor exposure is required before the oxide coating becomes sufficiently dense to prevent further corrosion from occurring. In rural areas, where air pollution is low, the oxide coating may take up to twice as long to develop. Over a period of twenty years, the exposed face of a weathering steel structure will lose only about 2 to 3/1000 of an inch in thickness. About ¾ of this occurs in the first two to three years while the oxide coating is developing.

Alternate cycles of wetting and drying are needed to develop the oxide film. Dew is particularly effective in developing the oxide coating since it absorbs sulfur and other air pollutants that assist in formation of the oxide film. However, care must be taken in the design of an unpainted weathering steel structure to make sure that the steel does get an opportunity to dry out periodically.

If there are water pockets where the steel is constantly wet, the protective oxide film does not get a chance to develop and the weathering steel will rust away almost as fast as conventional steel. For this reason, intermediate web stiffeners on a bridge girder are often cut about an inch short of the bottom flange to prevent a water pocket from developing. If there are some places where water pockets cannot be avoided, those areas should be painted.

Because weathering steels do not need to be painted, they offer a good opportunity to reduce maintenance expenses. Ordinarily, you don't expect to get something for nothing, but in the case of weathering steels, you gain the advantage of eliminating maintenance painting without paying much if anything for it.

Costs more per pound

A588 weathering steel costs around 2¾ cents per pound more than the con-

ventional A36 steel. However, the higher cost per pound is just about offset by the fact that the higher strength of the A588 steel permits the designer to use less steel. The AREA Bridge Specifications permit approximately 20% higher stresses for A588 steel than they do for A36 steel.

The cost of using weathering steel is a matter that must be determined individually for each particular design of bridge span. Generally, the cost inplace of an A588 weathering steel span is about the same as for the somewhat heavier A36 span, if painting costs are neglected. The exception to this rule occurs when the design is controlled by deflection requirements and the higher strength of the weathering steel cannot be fully utilized. The first cost of a typical weathering steel bridge is thus often less than the cost of a conventional design by the amount of the savings from eliminating the initial paint job, amounting to about 1½ cents per pound. In addition, there will be even greater savings from avoidance of future maintenance painting. Weathering steel is especially desirable in areas where pollution regulations rule out sandblasting and spray painting.

While the greatest application of weathering steels in railroad structures is probably in the field of bridges, it can also be advantageously used in signal bridges, floodlight towers, catenary supports on electrified railroads and other structures where painting is difficult or expensive. The initial cost of using weathering steel in light structures of this type will often be 8% to 10% higher than for a conventional painted structure, but the savings on the first cycle of maintenance painting are generally more than enough to make up the difference in cost.

What about appearance?

One question that is repeatedly asked concerns the aesthetics of a weathering steel bridge or building. As more weathering steel structures go up around the country, people are learning that the deep russet brown tones that are achieved after several years of weathering can be quite attractive. One of the earlier uses of weathering steel for buildings was in the John Deere Company headquarters building in Moline. In walking around the Loop, many of you have probably noticed the rich brown color of the Chicago Civic Center, which has been weathering since 1965. In some cases, weathering steel has been chosen for bridges because of its earthy hue which blends in with the landscape, and is less obtrusive than a bright shiny aluminum-painted bridge would be.

Where appearance is important, such as bridges over important highways, care must be taken in design to insure good drainage of the exposed steel surface to promote a uniform development of the oxide film, and mill scale should be removed, at least on the visible portions of the structure. Care should also be taken to make sure the fabricator realizes that the steel will not be painted, so that he does not paint shipping marks on the exposed surface.

Preventing concrete staining

Where the structure will be seen by the public, precautions should also be taken to prevent staining of the concrete. The bulk of the staining will take place during the first two or three years, while the steel is developing the protective oxide film. There are many proprietary products which can be applied to the concrete to shed the rusty runoff water, and will protect for two or three years. This is sometimes supplemented by wrapping plastic film over the concrete, for the first month or two, to prevent the bulk of the staining.

Other approaches include attaching drip plates to the bottom flange, or forming a rim or a shallow trough around the perimeter of the piers to collect the rusty water and lead it to a drain trough in some inconspicuous lo-

cation. Rust stains which do occur are limited to the very surface of the concrete and do not soak in. Where these are objectionable, they can be removed by applying a compound which loosens the rust deposits without damaging the concrete.

The fasteners used in assembling weathering steel structures should also be made out of weathering steel. Conventional threaded high-strength bolts, as well as pin bolts, are both available made of weathering steel. Where appearance is important, the head of the bolt should be placed on the exposed surface. Welding done on weathering steel bridges should also be done with special alloy electrodes which have the same weathering characteristics as the base metal.

Salt is harmful

Unpainted weathering steel offers prospects for railroads to save a considerable amount of money by eliminating maintenance painting, but weathering steel is not a cure-all. There are certain chemicals, particularly salt, that keep the protective oxide film from forming. Any portion of a weathering steel bridge that is subject to refrigerator car brine drippings should be painted. The air in the vicinity of the sea coast, particularly where there is a heavy surf, carries a considerable amount of air-borne salt particles.

While some weathering steel structures have been built only a few hundred yards from the ocean, in areas where there is very little surf, a careful investigation should be made before trying to use weathering steel for a structure less than ¼ mile from the ocean. We would also suggest getting a recommendation from one of the various steel companies' corrosion engineers before using weathering steel down wind of an industry that discharges corrosive fumes, such as a pulp and paper mill.

Where weathering steel is used on open-deck bridges on lines carrying considerable coal traffic, some additional precautions may be necessary. Weathering steel is resistant to coal acids and is widely used in the unpainted condition for side and slope sheets in hopper cars. In this application, it lasts much longer than conventional steel, but not long enough to be satisfactory for bridges. On bridges where coal dust accumulates between ties, the flanges should be protected with a durable paint.

Weathering steel has also been used for unpainted H-piles and steel sheet piling in ocean water. Experience has shown that the low-alloy steel will stand up to salt water corrosion better than carbon steel, particularly where there are no strong currents or wave action; however, the life of unprotected weathering type steels in salt water is definitely limited. Cathodic protection, or a very durable paint, should be considered for steel trestle piling, used in permanent construction in salt water.

One problem has come to light in using weathering steel, particularly for smaller structures, and this is the problem of availability. Steel warehouses and frabricators ordinarily do not stock a very wide selection of shapes in weathering steel and the mills require at least three or four tons to schedule a rolling. Before you design a structure in weathering steel that will use only small tonnages of material, it would be a good idea to check with your local steel company representative to see whether there will be any problems in delivery. Problems have also been reported in obtaining small quantities of lock-nuts and other hardware in weathering steel. Stainless steel or galvanized steel had to be substituted.

Metal Buildings – Present and Future

By F. W. Eldridge

Metal Products Division, Armco Steel Corp.

First, I want to thank you for inviting me to your annual meeting. Secondly, I would like to thank you on behalf of the metal building industry for using metal buildings for 125% of all your building applications. That's true, according to renowned authorities. The metal building industry received 125% of the railroad's construction during the year 1971, and we really appreciate that kind of business.

Until recently, I was located in our headquarters office at Middletown, Ohio, in charge of all of our marketing activities. Every year we analyze the F. W. Dodge statistics regarding square footage of construction in various markets and, of course, we look at the tonnage reports from the Metal Building Manufacturer's Association. We compare the two to see what percentage of business we're getting. In 1971, according to the statistics of MBMA and F. W. Dodge, we received 125% of railroad building construction.

Of course, I must admit that Dodge has surely missed some of your projects, especially the smaller buildings that might be used in yards and remote locations that certainly we wouldn't expect them to know anything about. But still, the percentage of your construction that goes to the metal building industry is quite substantial, and seriously we do appreciate your consideration of our type of construction. We know, and are very pleased, that the railroad industry has accepted metal buildings. You don't buy nearly as much as, let's say, the manufacturing market, but percentagewise, we can't complain one bit.

I thought it might be well today to start off with a brief review of the type of buildings that are being used in the railroad industry and, if you will, I'll now have the lights turned out and we'll go through several slides to illustrate some recent projects.

Metal Buildings Have Changed

These then are some of the more recent applications of metal buildings to the railroad industry. But now, let's talk about some of changes that have taken place in just the last few years that would affect your decision regarding new building construction.

(Slide) The image of our industry has changed significantly. The building you are now looking at is a very old one but one that is still seen all over the United States. Chances are they're still galvanized, though they may have been field painted. The slope is very high, probably a 4-in-12 roof slope; windows and doors are very utilitarian; attractive facia and eave trim were almost non-existent in the past.

(Slide) The metal building of today it quite a bit different. Perhaps the most important thing that has happened is in the area of appearance. Metal buildings today are simply more attractive, more aesthetic, more appealing to the wide variety of buyers that we work with. The biggest change in the appearance area is color. Galvanized steel is now color-coated by coil coaters before the panels are even formed. The color coatings used today are far superior.

(Slide) The color is guaranteed for as long as 20 years. This guarantee covers any significant color change, fading or chalking, that you might have

experienced in some of the earlier color buildings you bought; and of equal importance in the guarantee for chipping, cracking, glazing, blistering, or any of the other sundry items that can happen to color coatings. Truly, the color coatings of today are excellent, carrying very long durability ranges. The choice of colors is broader and much more appealing. Every metal building manufacturer has at least six choices and many of us go up to 10 and 12 choices of standard colors. Always available are what we call non-standard colors which cost you slightly more.

Another element that has greatly helped the appearance of metal buildings (slide) is the accessories we use—doors, windows, overhangs, canopies, eave projections and even skylights and wall lights have been drastically improved—both from the quality standpoint and from the appearance standpoint. Designers and engineers have learned to utilize the standard accessories and other associated accessories, such as brick, aluminum storefronts, or some of the other more conventional materials that improve the appearance of a structure.

(Slide) Metal buildings are more attractive today and, as a result, more accepted by the general public in their varying applications.

Roofs Are Flatter

Another area where very significant changes have been made is in the roof of a metal building. (Slide) Remember the shot we showed earlier of the small building with the roof slope of 4-in-12? These higher slopes are almost non-existent today. Roof slopes now are commonly in the area of ½-in-12, or 1-in-12, which is almost flat. The high-pitch roofs are just not preferred in this day and age. Lower slopes mean less attic space that might need to be heated; outside appearance, of course, is greatly improved by the lower roof slopes.

But to reach this level of the almost flat roof, the metal building industry has spent many hours in developing the joints we use in our roof deck. (Slide) Armco had a standing seam roof since 1930. But, within the last five years we have made some very definite improvements in this technology. The roof panel is still two or three inches deep, it still has the positive interlock between the male and female ribs, but today we have greater protection in watertightness by using plant-applied sealants in the female rib to give us greater protection and the rib is more securely locked.

(Slide) To keep the ribs securely locked together, we developed a mechanical device that runs up and down the room crimping the rib of the panel after they have been placed.

(Slide) The roof crimper is the final touch giving you the very positive locked standing seam that has proven to be so successful.

(Slide) Of course, with the lower slopes, the subject of durability has become of greater concern. Aluminum-coated steel, though available for many years, is now used extensively in metal roof construction. The finish is guaranteed for 20 years in virtually all kinds of atmospheric conditions.

(Slide) Fasteners is another area of significant improvement. We no longer use the word "screw" to describe the exotic fasteners now being used in metal roof construction. They have been engineered and tested to a very high degree, including the washers that seal the openings, the drilling tip that drills its own hole, and even the tools that install the screws to assure proper seating of the washer. A roof that is almost flat puts extra pressure on these fasteners and their design must be better. I guarantee you they are far superior to designs used five and ten years ago.

Different Occupancy

The type of building occupancy has changed considerably in the last few

years, and, instead of just building bare undignified warehouses, we now build very sophisticated facilities, such as diesel repair buildings, manufacturing plants, schools, etc., and a roof suddenly is required to do a much better job than it used to. (Slide) Openings are more common today for such things as air intake, air-exhaust units, roof-mounted equipment, ducts and vents of all sorts, sizes and shapes. Great attention has been given to developing the proper curbs and flashings that allow these roof penetrations to operate effectively for many years without maintenance problems.

The development of these lower roof slopes has led to another big change in the metal building industry, and this involves our framing systems. (Slide) Now that we have the low slopes, we are able to make our buildings very wide with only a single gable. We virtually eliminated the need to build with valley gutters or interior drainage systems that always cause a problem regardless of how careful you are in handling it. This particular building is in Monroe, Ohio. It is 600 ft wide with a single gable located in the center, giving us 300-ft runs on either side.

Beam-and-Column Building

Naturally, we don't go 600 ft wide with a clear span rigid frame, which was the predominant metal building being used some years back. Now we have (Slide) the beam-and-column building which is available in a wide variety of bay spacings.

The beam-and-column building has opened up many new markets for the metal building industry and is especially suitable for the lower roof slopes without valley gutters. (Slide) The framing system is perfectly suited for various material-handling systems, auxiliary loads that will be attached in the framing system, and is all designed by a computer that can easily accept these auxiliary loading conditions.

(Slide) A good example is this job for Columbus McKinnon in Ontario, Canada, which is subject to very heavy snow load and a large number of interior concentrated, and even moving, loads. The beam-and-column building has opened up all sorts of new avenues to building designers.

Mill Type Building

Another change being made in the metal building industry is in the area of mill buildings. (Slide) By mill building I mean the very heavy structural type buildings that have heavy crane loads — 10, 20, maybe even 30-ton cranes; high buildings that require an interior clearance of 30, 40, even 50 ft high. You can't supply these buildings in the more common rigid-frame clear-span design.

This mill building design is especially suitable for diesel-repair shops (slide). The U.P. job in Idaho that we showed earlier is a good example of this new capability within the metal building industry.

(Slide) Each truss building is custom-designed, but designed with a computer program rather than custom calculations.

(Slide) And, of course, most of the components are repetitive in nature, especially in the area of wall cover and roof cover.

(Slide) The mill building has now gained full acceptance in the heavier applications that are so often required.

Another change that is worthy of note is more a philosophical change rather than a product change. (Slide) Non-standard buildings have almost become standard in this day and age. Several years ago you would ask us for a special size or special shape, or special loading condition, and we would say, "No, we can't do it, it's not standard." Today, with our computer technology, there are very few project requirements that we cannot satisfy with a metal building system. A beam-and-column building can easily accept jack trusses which allow us to eliminate or relocate interior columns.

(Slide) Our bay spacing used to be limited to 20 or 24 ft. Today we can utilize bar joists which allow us to increase our bay spacing up to 40 ft. Many of these changes we make in our own plant through our own design department. However, many changes are made in the field by our qualified network of building dealers.

(Slide) In the old days, field modification of a standard building size or shape was very difficult and usually quite expensive. Today, the network of building dealers throughout the United States make field modification a very simple and economical solution to your design problem. This, of course, is subject to the contract agreements with your local brotherhoods.

Moving quickly through another change that has taken place, we should mention the improvement in wall system. (Slide) KOR-MET is a new sandwich wall panel being manufactured by Armco.

(Slide) This panel gives you both a steel interior and exterior surface, color-coated, with a three-inch polyurethane foamed-in-place interior core. Certainly, the material price is higher than the old methods of insulating and finishing out a metal building, but the erection prices are drastically reduced by such a product.

Offers Design Service

Another area that involves change deserves a great deal of discussion that I won't attempt to cover in its entirety today. We call it (slide) "Design and Build." Again, we are talking of something of conceptual, rather than an actual product change, or product development. "Design and Build" is a full service capability now being offered by most of us in the metal building industry. In the beginning, the metal building industry offered you a metal shell —either knocked down or erected. It was up to you to develop the basic plans, handle your own foundation, electrical, mechanical, or whatever else went into the building. All we could do was erect a metal shell. Through our dealer organizations, we developed one step further to where you could design the project and our dealers could furnish a full construction service that could pour your concrete, erect your metal building, finish up the inside, handle all mechanical trades, in essence, give you a total package.

Due to the repetitive nature of this type of construction, and the speed with which we could accomplish this construction package, we have rapidly moved into the area of designing, as well as building your building for you. We have (slide) the people to furnish a complete design and build service. Our dealers either have in-house capabilities for complete design, or they have developed a relationship with local engineers and architects whereby they are called in as consultants on a particular project. The primary advantage to you in a design-and-built system is single-source responsibility. President Truman used to say, "The buck stops with me." When you give us the full responsibility for the project, you get your building quicker and more economically because, nine times out of ten, your project is a repetition, or at least a close proximity, of another project we have already been through and gained the experience and knowledge to take maximum knowledge of mass production in both design and construction. As I said, this subject is very involved and I could talk a great deal more about it, but for the moment I'll leave it as it is.

So we have now covered a number of changes that have taken place in the metal building industry that are significant and have made us ever more acceptable in the market place, especially the railroad market place.

Let's review these changes. (Slide) Basically, they include aesthetics — metal buildings are more attractive; their appearance is more acceptable. Lower slopes are the name of the game and with these lower slopes, we've

moved into wider buildings—buildings with center columns with a single gable —no valley gutters. Mill buildings are now commonly supplied by the metal building industry. There is no need to go through custom design just because you have heavy loading conditions, or high interior clearance requirements. Non-standard buildings have now become almost standard buildings with our improved computer technology and use of standardized components. And the last item, "Design-and-Build" – the conceptual change that saves you time and money.

Consider Profit

To finish up my discussion today, I think it is very important that we consider the benefits to you that are offered by the metal building industry. Historically, we've talked about such things as speed of construction, the fact that metal buildings are easily expanded, durability, etc. These are all definite benefits or advantages to you in the railroad industry. They save you money. But really, (slide), the real benefit to you—the primary one—that we should all put first and foremost in our minds as members of this capitalistic society that we live in—is profit. Profit is the name of the game. Most of us work for companies—companies that are in business to make a profit.

Another way, and perhaps a more popular way of talking about profit, is to talk about (slide) return on investment. When your company invests money—puts out a capital expenditure —it expects a reasonable return on that investment. Most buildings very definitely fall into this category. What is the return on our investment? A bridge engineer may not always relate a particular project to return on investment, but behind all of our decisions, this one criteria is paramount.

People, manpower within your company, are an investment and the return should, and usually is, measured by management. A metal building must be measured against a return on investment. And surely, the durability aspects, ease of expansion, some of these common benefits, are measurable elements.

The Factor of Time

But, the most critical and very often the most overlooked aspect of building a new building is not the material benefits, but the factor of time. (Slide) Time is the single most influential benefit the metal building industry has to offer to you—the industrial user. Once you and your company have made a decision, even a preliminary one, that a new building is needed for a particular aspect of your busines, you have said that your company can receive a return on the investment you are about to make.

Let me draw a simple example. Let's say that you have only a single location for repairing your diesel locomotives. It's located here in Chicago. However, your track stretches all the way to Texas. Locomotives that need repair must be brought to Chicago. Management says, "Why don't we build a diesel-repair facility in Texas so that we don't have to bring this equipment all the way to Chicago for repair?" An analysis is made. It is determined that your company can save "x" number of dollars by having this new repair facility located in Texas. The moment that decision is made, your company is losing "x" number of dollars each month until such time as that facility is actually in operation. The moment you've made a decision, even though it may be a preliminary one, your company is losing money until such time as you've completed the project.

In the investigation of such a situation, the common analysis is to say, "This project will cost us "x" number of dollars." Over a five-year period, maybe a ten-year period, we can save more than enough money to offset this investment. A thing that is so often overlooked, is the time it takes to put

the plan into operation. This element of time is the area where the metal building industry can offer you the greatest return on your investment.

Let's look at the time factor a little bit closer. (Slide) All of us understand construction time very easily, the actual time it takes to construct a building. The metal building industry has proven that it can complete your building much quicker than the more conventional means of constructing. Our red iron goes up quicker, our roofing materail goes on quicker, it is not effected as much by weather as other materials, it allows you to do your interior work such as mechanical process piping, etc. We can build your plant quicker than other types of construction.

Estimating Is A Factor

Another element though in this overall time aspect is estimating. How long does it take to bid on a project? In our industry we are working with repetitive elements, things that we are very familiar with. Estimating the cost of a project is a very simple process and one that can be done in a very short period of time. We can save time in the required estimating stage of a project. The bulk of our design is already done. Sure, you have a non-standard project. It might take four or five days, or maybe even ten days longer to run it through the computer program and come up with a custom design. But still, we can do it quicker, we can handle he final design phase quicker than any other type of construction you have available.

We're working backwards now into the area that it often overlooked. We're all the way back to where you are required by your management to come up with a preliminary budget for this project. Your Board of Directors, or your president, or maybe just your manager, wants to know how much is this project going to cost before we carry it any further. You've got to come up with a preliminary budget figure. How do you do this? The metal building industry can do it easily for you and quickly. This is our business. We've done it before. Our preliminary budgets are accurate, even though they are put together quickly. We're working in areas of the known, not the unknown. We've done similar projects. We can put together the preliminary budget that you must have to satisfy your management.

Calculations Already Done

Let's carry back even one step farther. Let's look at preliminary design. You've got to have a preliminary design before you can really come up with a preliminary budget figure. The metal building industry offers a variety of standardized buildings, standardized accessories. You can pick up the phone and call any metal building person that you've worked with and discuss the various sizes of buildings. This area can be established very quickly because you are talking about a known and an established framing system. You don't need to run any calculations to establish beam sizes. All of this has already been done and is waiting there for you to call for it. A preliminary design based on a standard availability of building systems can be done in a matter of days. Of course, you must still give consideration to your particular process, such as how are you going to arrange your diesel-repair facilities, how many tracks you need going through, how many locomotives you will have for repair, and the type of equipment going into the building. But very quickly these can be related to a standard building configuration and layout. Working backwards through this point, we have been able to move from step to step in a very logical sequence.

Moving farther down the line, the last item I have indicated here is ROI Justification. This is RETURN ON THE INVESTMENT JUSTIFICA-

TION. This is what your Board of Directors start with. Do you need this new diesel-repair facility in Texas? How much would it save us? These things are up to you. The metal building industry can't really assist you in determining these early decisions as to whether a new building located in a certain area will give you a greater return on your investment.

And, this category is where perhaps we lose the most time. How often have you been involved in a project for literally years where the feeling is a new building should be built in Timbuctoo, or whereever it might be and you've never even gotten down really to the stage of estimating the building? It's simply a discussion. "If we build that building there, we could save ourselves money in some other area." We talk about it, and we talk about it. Every company is the same. But the fact remains, that a quick analysis of a particular question could give you and your company a very preliminary return on investment analysis. Sometimes this early justification may say "yes." It would give us a good return on investment. But our company says, "No, we simply don't have the available cash, regardles of what it would do for our investment. We simply don't have the money available to build this million-dollar diesel-repair facility." So the project is not carried any further. Well, there's not a whole lot we can say about that. Either we have the money or we don't.

But, once the decision is made that we should build this new project, time, LOST TIME, is costing you and your company money. This is the area where the metal building industry can offer you the greatest benefit. We can save you time. We can get your building to the point to where it can start giving you a return on your investment. (Could I have the lights, please?)

The metal building industry is not new to you railroad people. We've been partners in this program for many years and I feel confident we will continue. But the thing that hurts me, bothers me I should say, more than anything else in our relationship is this subject of time. We have the product that fits your needs. This we are sure of. We have the construction techniques to build your project quickly and appropriately. But don't overlook the metal building industry in the early stages of your program. Let us help to save you time, and the workload, the effort that goes into any new project.

Pre-engineered metal building, as we have so often called it, should really be changed. Today it is a metal building system and in this day and age, system seems to be the magic word. We do have system, it is a system which you know how to use. Maybe we just haven't used all aspects of it to its highest degree. Gentlemen, I thank you once again for letting me visit with you today. And, if there are any questions, I believe we have a few minutes and I will try to answer any that you have. Thank you for your kind attention.

The ICG's New Bridge Across Pass Manchac

By D. S. Bechly

Assistant Chief Engineer Structures, Illinois Central Gulf

D. S. Bechly

Illinois Central Gulf Railroad Bridge No. 874-6 crosses Pass Manchac approximately 40 miles north of New Orleans. The old bridge at this location was constructed in 1904 and consisted of one 172' through-plate girder swing span supported on a masonry pivot pier. This pier had been constructed by driving approximately 500 piling, which were encircled with a steel cylinder cell stuffed with concrete blocks and filled with concrete. The remainder of the bridge, including the rest piers for the drawspan, was constructed of treated timber. The north approach consisted of 889 ft of open-deck timber trestle and one 16 ft concrete slab firebreak, and the south approach consisted of 1371 ft of open-deck timber trestle and two 16-ft concrete slab firebreaks.

Originally the bridge was of double-track construction. In 1935, it was decided to single-track traffic over the bridge because of the condition of the trestle approaches. The west track was selected, and the bridge under this track was reinforced by driving additional piling in the bents. The trestle alongside was left in place with the deck removed 7-in by 16-in timbers were used to construct a horizontal bracing system on top of its bents to give lateral support to the remaining track. This was done because the piling in the bridge was unsupported for the approximately 40 ft of length below the water line.

From 1935 until 1972, when the new bridge was put in operation, the old trestle was maintained by driving additional helper piles, installing what bracing could be installed and renewing the deck. In spite of this, the maintenance expense continued to climb as each year went by.

In the early Sixties a new condition of deterioration was noted when a new form of marine borer made its appearance and started to do severe damage to the creosote piling just below the waterline and just above the mudline. Studies were then made to determine the most economical method of renewal, and in August of 1969 our management authorized an expenditure of approximately 2.4 million dollars for the construction of a new bridge on an offset alignment 50 ft to the east.

The firm of Hazelet and Erdal, Consulting Engineers, Chicago, was retained to design the new structure. Consideration was given to the construction of a through-girder type of bascule bridge, but design considerations caused this to be discarded in favor of a 121 ft open-deck rolling-lift through-truss bascule span. Due to the close proximity of the old bridge to the new bridge, and in order to maintain railroad and navigation traf-

fic during the construction period, it was decided to erect the new bascule span in the open position. Two additional open-deck steel spans, one 28 ft in length and the other 51 ft in length, were constructed immediately adjacent to the bascule lift span. The remaining approach spans consist of 60 ft ballast-deck pre-stressed concrete box girders, 16 spans in the north approach and 22 spans in the south approach. This results in an overall length of bridge of 2484 ft.

The substructure consists of concrete caps founded on large diameter, hollow, prestressed-concrete displacement piles.

(Slide) This is a System map of the former Illinois Central Railroad. The arrow points to the general location of the bridge.

(Slide) This slide shows the general location of the bridge at Manchac, Louisiana over Pass Manchac, which is a channel connecting two lakes—Lake Maurepas on the west and Lake Pontchartrain on the east. This bridge is one of the busiest of all navigation openings on the Illinois Central Gulf, requiring approximately 2500 openings annually.

(Slide) This is a view looking south from the north end of the old bridge.

(Slide) The contract for the bridge was awarded to Brown and Root, Inc. of Houston, Tex. Construction was started in late February, 1970. This view shows the 300-ton Clyde floating crane used by the contractor. The depth of water in the channel is approximately 40 ft. However, the water near the ends of the bridge is only a few feet deep and it was necessary for the contractor to dredge a channel for his floating rig to maneuver in these areas.

(Slide) This overall view shows the old bridge from the swing span to the north shore line and the 300-ton crane. In some of the forthcoming slides you will see the new highway bridge which was constructed to replace an old low-level bridge.

(Slide) This view shows the contractor's crane setting a 100 ft long, 54-in, round pre-stressed concrete test pile for the main trunnion pier. We had secured approval of the corps of Engineers and the Coast Guard to block one channel, and the new trunnion pier was installed in this blocked opening.

(Slide) This is a view of the test pile as driven. The pile was driven with a Raymond Eight Ought hammer, with 25,000-lb ram. By varying the vertical stroke, it could be used to obtain either 33,300 or 68,800 foot-pounds of energy per blow. According to plan, this pile was driven to 10 ft above cutoff and then test-loaded with concrete slabs, in accordance with AREA specifications.

(Slide) This shows the first increment of load in place, which consisted of 135 tons. The total settlement under this load was .121 inches, which was within the allowable tolerance.

(Slide) This view shows instrumentation for recording the settlement of the pile under load. The gauges, which can be seen fastened to timber piles, are a dial type. They are spring-loaded with a gear ratio that will give a reading of 1/10,000th of an inch. The pile was loaded with the first increment of 135 tons and allowed to set for nine hours; then an additional load of 65 tons, which increased the total load to 200 tons, was applied and allowed to set for nine hours; then an additinoal 65 tons for another nine hours; and then 70 tons to increase the load to 335 tons. At that point it became obvious that the plie was going to fail in settlement.

(Slide) This view shows the final increment of 65 tons being placed, to up the total load to 400 tons. The pile had already failed with a settlement of 3.9 inches, so this final load was not allowed to take full bearing. Following this test, the pile was driven an additional 8 ft and again test loaded. This time it successfully supported the 400-ton load.

(Slide) This view shows the Raymond 0000 hammer being positioned for driving a 24-inch square pretressed-concrete test pile for the north abutment. This hammer delivered 48,700 foot-pounds of energy per blow. These piles were precast in 64-ft and 67-ft lengths and were driven to a bearing capacity of 200 tons. This type pile was also test loaded with 200 tons of concrete slabs and successfully retained the load.

(Slide) These next few slides were taken at the Pre-stressed Concrete Products Company plant at Mandeville, Louisiana, where the piling for this job were cast. This view shows the machine that shapes the spiral reinforcement for the piling.

(Slide) This view shows the form for one of the piling ready to be placed in the spin-casting machine. These red lines you see inside the form are one-inch rubber hoses used to form the holes for the pre-stressing strands.

(Slide) This view shows the pile in the spin-casting machine.

(Slide) Immediately after the pile is cast, it is taken out of the casting machine, set up vertically and placed in a building where it is steam cured for approximately one hour. It is then rolled out of the building and an overhead crane is used to withdraw the form, including the red rubber hoses which formed the holes for the pre-stressing strands. These piles are cast in 10-ft sections. After the forms are removed, piles are transported to a curing yard, where they are stored vertically, sprayed with a curing compound and allowed to cure in air until they have acquired sufficient strength as determined from breaking test cylinders made at the same time the piles are cast. These piles were cast with 5000-psi concrete.

(Slide) Next, the pile sections are laid end-to-end on the casting bed in sufficient numbers to obtain the length desired. Wooden separator blocks are placed between the individual pile sections, the pre-stressing strands threaded through their holes and the gap between individual pile sections filled with quick epoxy grout.

(Slide) The strands are now pre-stressed and the holes around them pressure grouted.

(Slide) This view shows a 54-inch pile being driven for one of the four-pile approach bents. You will note the piles for one four-pile bent in the immediate foreground. The framework that you see is setting over two additional four-pile bents. This framework is approximately 150 ft long, made of steel, and is positioned over the two previously driven bents and cantilevered forward to act as a templet for driving the third bent. The contractor leapfrogged all the way across the bridge with the template in this manner.

(Slide) This is another closer view of the pile template.

(Slide) This is a closer view of four-piling for one bent after driving. These particular pilings are 2 ft above cutoff, so it is obvious that cutoff is below the water line.

(Slide) This is a view of the portable, steel, sheet-pile cofferdam used by the contractor to permit cutting off the piling and getting them ready for the concrete cap. This steel, sheet-piling, portable cofferdam was approximately 16 ft square and 16 ft deep and weighed approximately 20 tons. It was easily placed in position by the 300-ton floating crane. Most of the piers required only one such cofferdam. However, they were fabricated so that one could be set on top of another and the two bolted together to reach greater depths. The procedure was to position the cofferdam over the piling, settle it to the mud and then place one of the 40-ton concrete slabs previously used to load the test piles, on each corner to push it down into the mud. This permitted them to pump down the two or three feet inside the cofferdam to de-water it for cutting off the piling and getting them ready for the concrete cap.

(Slide) This is another view of the same cofferdam. You will note a corrugation effect in the inside of the piling. Since all piling was of a predetermined length and could be driven to very near cutoff, it was specified that the top 6 ft of each pile be spirally ribbed, as you see here, so that a good bond would be obtained between the piles and the cap.

(Slide) Since the 54-inch piling was hollow and was driven open-ended, the void inside the pile filled almost to the water line with the soft gray clayey silt of the river bottom as the piles were driven. The specifications required that this clay be removed to a minimum depth of 8 ft below cutoff and the void filled with sand to 6 ft below cutoff. Since the inside diameter of the piling is only 44 inches, it was almost impossible to operate excavating equipment. To perform the excavation by hand would have been quite expensive, so the contractor devised an air-water jet, which he forced through the soft clay to the required depth. When turned on full force, this extruded the clay plug as shown in the next slides.

(2 Slides) After the major portion of the clay had been removed in this manner, the inside of the pile was thoroughly washed and cleaned with the air-water jet, and the sand fill placed.

(Slide) This is a view of the forms for the precast-concrete caps being constructed at the yards of the Prestressed Concrete Products Company.

(Slide) This view shows the reinforcement cage for a concrete cap, which was completely tied on a platform. The cage was then set into the forms and the cap cast in the upside-down position.

(Slide) This is a view of one of the completed caps setting on a barge at the bridge site and rigged with lifting cables ready for placing in position. Obviously the cap must be turned rightside up. The next slides show how this was done.

(Slide) This view shows the righted cap being positioned over the piling.

(Slide) This view shows the cap in final position ready for placing concrete. The cap is set to elevation and aligned by inserting wedges between the bottom of the cap and the top of the concrete piling. Each pile is then wrapped with galvanized sheet metal to close the gap between the top of the pile and the bottom of the cap. Concrete is placed in the cap to fill the voids in the piling through the 10-inch round holes which can be seen at each end of the cap. Prior to placing the galvanized metal, the inside of the cap is sprayed with an epoxy adhesive for improved bond.

(Slide) This shows the galvanized-iron wrapping around the top of the piles.

(Slide) This view shows one bent in the foreground which has been completed and the placing of the next cap.

(Slide) This is a view of the north concrete abutment after it had been partially backfilled

(Slide) This view shows the cofferdam for the rest pier at the south end of the new bascule span. Since this pier was larger than the approach bents, was to be cast in place, and because of the depth of the water, the prefabricated cofferdams could not be used. A standard steel sheet-pile cofferdam was driven.

(Slide) This view shows the cofferdam with the piling driven.

(Slide) This shows the placing of concrete for one-half of the main trunnion pier. This pier is 53 ft wide, 44 ft long and about 8 ft thick. It contains approximately 700 cubic yards of concrete.

(Slide) This view shows the first half of the pier completed and the second half being concreted. The concrete was mixed at the site on a barge in a 2½-cubic yard concrete mixer.

(Slide) This is another view showing the placing of concrete for the second half of the trunnion pier.

(Slide) This is a view showing the setting of one of the 60 ft precast slabs. Note the structural steel spreader frame being used.

(Slide) This is another view of the same thing.

(Slide) This is another view of the same thing.

(Slide) Another showing lowering the slab into place.

(Slide) This view shows Slab No. 1 in final position.

(Slide) This slide shows one of the concrete caps with two spans resting on it.

(Slide) This is a view of the completed north approach.

(Slide) In order to construct the new embankment approaches to the bridge, which extended about 1500 ft in each direction from the ends of the bridge, the contractor elected to bring in placement equipment by barge and unload it at the site.

(Slide) This view and the next show how he used his 300-ton rig to lift the Koehring 1000 Crane weighing approximately 90 tons, back from the embankment to his barge. The new embankment was to be constructed on a very marshy type land, which is covered with water all of the time, and into which you would sink up to your knees, or deeper just by walking in it. This required special methods to be used.

It was determined from borings that the same type soil extended for a great depth and it would not be practical to remove it and replace it with a firmer material. We were aware, however, that the existing embankment had also been constructed through this same type of ground, so it was assumed that we could place, roll and compact layers of a good fill material, and, if done properly, we could reasonably expect the embankment to carry the new rail line.

The fill was constructed immediately east of and adjacent to the old embankment beginning approximately 1500 ft north and south of the ends of the bridge. As the fill approached the bridge, more and more of it was beyond support of the old embankment. Near the bridge ends, the fill was built about 60 ft wider than required to an elevation 5 ft above the natural ground to counterweight the underlying strata so that any tendency to heave outside the theoretical toe of slope would be counteracted. The existing embankment, of course, also acted in the same manner on the opposite side.

For filling material we selected finely graded crushed stone, hauled in by rail from southern Illinois and Kentucky and delivered to the contractor at the ends of the bridge. This stone was used instead of local material because of its greater density. The contractor used the Koehring 1000 Crane to unload the stone from gondola cars into dump trucks which were used to spread the material. Further spreading and compaction was done by a bulldozer and sheepsfoot roller. Approximately 5,000 tons of stone were used at each end of the bridge.

At the south end there was not enough shoulder to work from, so he elected to have the materail delivered to him in New Orleans, where it was unloaded onto barges and brought to the site by tugboat. He then unloaded the material from the barge into trucks and again spread and compacted it with bulldozer and sheepsfoot roller.

(Slide) This view shows the south approach after the existing embankment had been grubbed.

(Slide) This shows the almost completed south approach fill.

(Slide) This is a view showing the completed north approach embankment.

(Slide) This is another view from the north end of the bridge.

(Slide) This is a view looking north from the end of the bridge.

(Slide) This view shows riprap protection for the embankment at the bridge ends.

(Slide) Here we see the complete steel structure in the closed position. From left to right we see a part of the

final pre-stressed concrete span of the north approach; the 28-ft steel, track-girder span over the pier, the 121-ft rolling-lift bascule span and a 51-ft steel, deck-girder span starting the south approach. You will note that the old swing span has already been removed and the new span is in operation.

(Slide) This is a general view of the north from the northerly concrete span in the south approach. Note that all of the steel spans are open-deck, while the concrete spans are ballasted-deck.

(Slide) There we have a general view to the south from the north approach. To the left is the access walkway to the operator's house. Also note that ladders and catwalks are provided for access to the machinery.

(Slide) Here we have a view of the bridge in the open position. Note that the operator's house is positioned to provide a clear view of the channel in both directions.

(Slide) Old hands at movable bridges recognize the counter balance voids shown here. Final adjustment required the selective loading of the voids in order to minimize motor effort in both opening and closing operations.

(Slide) The operator's house is the upper enclosure and the control house is the lower building. Again note the location of the operator's house to allow a clear view of the channel.

(Slide) A view of the machinery deck showing the main power line. The two main motors at 20 hp each, with brakes, are at the ends of the line. A 7½ hp auxiliary motor can be seen in the foreground.

(Slide) This is a view of the operator's panel. The indicators show the position of locks and wedges, drive motor and braking functions and span position. Although not called for in the specifications, an external de-bugging device of the form shown in the upper center seems to have been included.

(Slide) Fenders were, of course, constructed to protect the new structure. This rather unconventional construction utilized a portion of the old swing span center pier. The channel side of the pier was cut off to meet clearance requirements.

(Slide) This view shows the more typical pile cluster and timber rail-type of fender protection which was used at the other three corners of the channel opening.

(Slide) This is the rest pier. Note the channel traffic signal on the right. Visible at the left edge of the concrete cap, are hooded lamps which are a part of an electric-eye system for detection of water traffic. These are installed for the ultimate operation of this bridge by remote control from New Orleans.

(Slide) Here we see the rail joint at the lift end of the bridge. Metal ties were used under the joints to insure trouble-free operation. As a matter of information, welded rail was used throughout the project where practical.

(Slide) Note the inner metal guard rails, as well as timber outer guard rails on the open-deck spans.

(Slide) Rail expansion devices are desirable where welded rail is used near a movable bridge. Here we see such installation used at this bridge.

(Slide) A microwave tower near the site was put to work in a manner not thought of in its original design. A sharp eye will detect a wind speed and a direction-measuring device about halfway up the right hand side of the tower. This device is connected to instrumentation in the operator's house.

(Slide) This is the auxiliary power station. A diesel engine-generator set which can be started from the bridge is housed here for emergency use.

(Slide) Now, with all in readiness from the north. . . .

(Slide) From the center. . . .

(Slide) and, to the south. . . .

(Slide) The first scheduled train crosses the new bridge on January 11, 1972. It was AMTRAK Train No. 59, the southbound "Panama Limited".

(Slide) Since then, of course, we have been busy.

(Slide) No comment.

Use of Laminated Timber Stringer In Railroad Bridges

By Donald O. Barth

Manager, Engineering—Computer Sciences, Koppers Company, Inc.

D. O. Barth

I'd like to say how pleased we are to be invited to participate in this meeting of the Bridge and Building Association. Our pleasure is at least threefold:

(1) It is always gratifying to be thought well enough of to be asked for advice and information.

(2) We feel that we truly *do* have good advice and information on the use of structural glued laminated material in railroad bridge construction.

(3) The potential exists for any help we can be to you; to be returned to us in the form of increased volume of sales.

Certainly no one needs to tell a group of railroad bridge engineers and builders that wood is an important structural material or that it deserves their interest. Since the beginning of the railroad system in this country, wood has played a major part in filling the construction needs of railroading.

There are now about 1800 *miles* of wood bridges in service on American railroads. This is approximately 40% of the total bridge trackage. By far the great majority of these structures are of solid sawn timbers, which is completely natural. Even though laminated material does have certain advantages over solid-sawn timbers, as long as the availability of solid material in the cross-sections, grades and lengths desired remained good, simple economics dictated its use. We in the laminating industry couldn't take big trees, saw them up into boards and glue them back together in competition with the original big trees.

The earliest use of glue laminated material in railroad bridge construction that we know about was in 1944. The Texas and Pacific Railroad put 11 7-in. by 16-in by 14-ft. Southern Pine stringers in a trestle on their main line near Woodlawn, Texas. This material was treated with creosote.

After this initial installation, several others followed in 1945 and 1946 in various parts of the country:

—Posts, caps and sills in a trestle for the Detroit, Toledo and Ironton Railroad.

—Southern Pine caps and stringers in an industry spur of the Southern near Alexandria, Virginia.

—Douglas Fir beams and stringers in trestles on the Chesapeake and Ohio near Newport News, Virginia and Ameagle, West Virginia.

—Douglas Fir stringers and caps in a Southern Pacific trestle near Durmid, Colorado.

All of these installations have been receiving periodic inspections. No de-

lamination has taken place, and the checking that has occurred is generally less than in solid timbers in the same exposure conditions. There is certainly not enough absolute data yet to establish a service life for glued laminated bridge material that has been properly designed, manufactured, preservatively treated and installed, but the indications are extremely favorable.

As glued laminated material started to be used, research was undertaken to confirm the allowable stresses that were being used, with particular emphasis on the effects of repeated loading cycles and the speed at which the heavy live loads were applied. Most of the research was carried out by the staff of the Association of American Railroads at the Engineering Division Research Center here in Chicago. Their investigations were largely undertaken as a result of requests for data from American Railway Engineering Association committees. Committee 7 — Wood Bridges and Trestles generally initiated the laboratory testing and Committee 30 — Impact and Bridge Stresses, the field tests.

Many of you are without doubt more familiar with the tests and their results than I, and I won't comment further on them except to identify a couple of the reports:

Report *ER-26* "Laboratory Investigation to Determine Static and Repeated Load Strength of Full-Size Douglas Fir Glued Laminated Stringers".

Report *ER-52* Studied the same things for Southern Pine.

I only mentioned them to show some of the work that has been done along these lines, and to indicate that studies of a technical nature have been completed to substantiate the use of glued laminated material for railroad bridges.

As the years passed, relatively little expansion in the use of laminated members for railroad use took place until quite recently. All of us in the laminating industry are now receiving an increasing number of inquiries about all types of material for bridge use. As examples, let me list:

a. The two timber trestles supplied to the L&N and installed near Mobile, Alabama.
b. The Seaboard Coast Line has placed a substantial order for bridge stringers, intended both for new construction and replacement work.
c. The Milwaukee Road has placed an order for material to be used in a prototype bridge structure.
d. The Burlington Northern is continuing to express *real* interest in the whole area of laminated material for bridge construction and maintenance.

Describes two L&N Bridges

At the beginning of my talk, I intimated that there may be some way we could be of help in expanding the use of laminated material for railroad bridges. Aside from just talking about various jobs, I thought perhaps the most useful thing to do would be to go through some of the design steps in an actual bridge. The ones we know most about right now are bridges 167 and 168 on the L&N mainline about 35 miles from Mobile, Alabama.

The problem there was to rebuild, under traffic, two L&N standard ballasted-deck timber pile trestles. The existing bridges used solid sawn caps and stringers with pile bents spaced 12′-6″ on centers. The first decisions made, after the initial one to use laminated stringers, involved the spacing of the replacement pile bents. Working together, L&N and Koppers engineering people selected a 19′-0″bent spacing which made use of 20′-0″ glued-laminated stringers. I might point out here that this does not necessarily indicate a maximum length of span, for the stringers. Laminated material is available in nearly any size required. The full consideration of pile capacity, bent total load, soil and foundation conditions, construction time

and all the other factors involved indicated that for this structure, 19'0" was a good pile bent spacing.

This spacing selection was certainly influenced by the L&N's decision to go to a Cooper's E-80 loading for these structures, instead of the E-72 that had been used earlier. This trend to greater design loading is consistent with the growing actual loads of heavier locomotives and increased car loadings.

O.K.—once the basic span and loading questions are settled, the calculations of stringer size can begin, following the format found in AREA "Design of Wood Railway Bridges." I have reproduced by calculations in the belief that you could follow them easier.

Right now I'd like to say that I feel as though I'm "carrying coal to New Castle." I recognize that all of you people are experts in the field of railway bridge design, and that very likely I am about to insult your intelligence. Some of the inquiries we've received though, indicate that there may be some specific information relating directly to the laminated material that could be discussed profitably.

With that, let's look at the calculations:

(Discussion of calculations and size selection follows.)

There—so it is demonstrated that 10—9"x18" laminated stringers in each bay will do the job. This is what the L&N ordered and what was furnished to the job.

Again, running the risk of going over old ground, I thought some of you might be interested in seeing the manufacturing steps that went into producing these laminated stringers or members like them.

(18 slides)

Next, I'd like to show you the bridge itself:

slides
general view—number
close-up of typical bent
head on view of bent
side view showing old trestle pile cut-offs—new spacing
close-up of clip L detail
use of tar paper vs. high density polyethylene, buffer pads for abrasion
general view—locomotive on under traffic

You can see that this bridge is nothing fancy. It doesn't make our advertising guys do flip-flops or generate a lot of spectacular attention.

As Conrad Hale, Engineer of Bridge Design for the L&N says:

"It is a standard 'work-horse' trestle, quite similar to hundreds on many U.S. Railroads. It is designed to 'work' for the railroad—will probably never even be seen by the general public. It represents a real and continuing application of glu-laminated timbers for the nation's railroads, and the use of such timbers in larger and longer structures whenever they are built or renewed is a definite possibility.

Mr. Hale goes on to say, "It is evident that glu-laminated timbers, when incorporated in the design stages for new replacement bridges of this type, can be used at relatively little or no premium 'in-place' cost over solid timbers."

We feel that the use of glued laminated treated material for railway bridges of all types is an idea whose time has come. There is an increasing concern over possible shortages of solid sawn timbers in the required grades and sizes for the standard designs now in use. There is solid background of experience with laminated material, with installations approaching 30 years of practically maintenance-free service and no real end in sight. During that time, laminating has grown out of its childhood into a substantial, self-regulated industry with the integrity and capacity to assure any railroad of the proper response.

Timbers In Short Supply

Without trying to develop a panic over the use of sawn timbers, there are some problems connected with

their use. Unfortunately, these problems are increasing in number and severity. There is plenty of lumber, its just the large size timbers that are becoming difficult to find.

(1) Second and third growth timber stands simply do not yield the density and structural integrity in heavy timbers today as the virgin forests did in the past.
(2) Longer "lead times" are required to obtain the sizes and grades required. These large timbers must generally be "found" on the stump and specially cut and air seasoned for use.
(3) The competitive usage of timber for other products permits, even encourages, the cut of smaller trees. This further decreases the availability of the large log needed for cutting heavy timbers—the trees just aren't permitted to grow that big.
(4) Heavier and heavier loads are coming on the bridges, the result of increasing car-loads and larger locomotives. All bridge components need *greater* structural strength, in times when it is a struggle just to maintain what had been available.
(5) Solid timber structures are limited to relatively short spans because of the problem of obtaining heavy timber sizes in extra long lengths. This does not enable the greatest economy to be sought for the structure as a whole, considering foundations and installation costs as major factors of cost.
(6) Solid-sawn timbers are continuing to increase in price in the marketplace.

In contrast, glued laminated timbers offer a considerable list of advantages, including:

(1) Ready availability.
(2) Structural integrity "engineered" into the finished product. "Man made" or "shop grown" timbers place the high grade material in high stress areas, permit lower grade material in areas of low stress.
(3) Superior treatability—all material is kiln dried. As a result, the finished timbers are really penetrated by the preservative.
(4) Increased spans—there is no real limit on span from the material standpoint. Our Canadian subsidiary looks on their 8′ diameter treating cylinder as the limiting factor for bridge girders and has furnished spans in excess of 140′.
(5) Increased spans result in quicker total installation. There are fewer pile bents to put in, less material to handle in the field, under traffic.
(6) The increasing loads of trains and locomotives are more easily handled by proper engineering and selection and placement of material in the finished timbers.
(7) The cost of producing laminated material is showing a steady downward trend as increased technology and mechanization take hold in the laminating plants. For example, Koppers has spent the last several months and a substantial chunk of money in the development of an automated process. We call it "KAL"—"Koppers Automatic Laminator." Undergoing its final acceptance and performance tests now, this machine enables one man, operating from a control console, to spread adhesive, assemble, clamp and completely cure four 9″x18″x 20′-0″ stringers, such as we designed here, in 20 minutes? That's almost as fast as you need them.

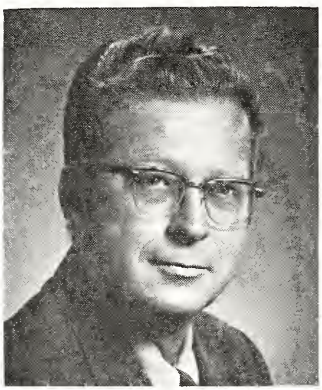
In closing, I'd just like to point out that the railroad industry and the laminating industry seem ripe for romance. The most sensible answer to many, many railroad bridge problems is a timber bridge. In almost all instances, the most available, bent engineered, and, in the long run, most economical timber bridge uses glued laminated timbers. We at Koppers in the Forest

Products Division feel particularly well suited to provide the finest overall service to increase the use of laminated timbers in railway bridges based on our engineering staff, manufacturing facilities, treating plants and many years of experience in working with your industry.

Prestressed-Concrete Railroad Bridges—New Developments, Problems, Etc.

Committee Report

COMMITTEE—C. A. Hughes, *Chairman*, asst.engr.br., S.P., San Francisco, Calif.; D. P. Callahan, *Vice Chairman*, b.& b. supvr., Sou. Monroe, Va. G. L. Tysinger, *Vice Chairman*, b.& b.supvr., Clinch.. Erwin, Tenn.; W. F. Baker, v.p.& gen.mgr., Shelby Precasting Corp., Memphis, Tenn.; R. K. Corbett, gen.fore.b.& b.& w.s., A.T.& S.F., San Bernardino, Calif.; A. R. Dahlberg, asst.engr., A.T.& S.F., Amarillo, Tex.; J. A. Goforth, ch.engr., Clinch.. Erwin. Tenn.; B. J. King, br.engr..Coast Lines, A.T.& S.F., Los Angeles, Calif.; G. Leyh, asso.tech.dir., Concrete Reinf. Steel Inst., Chicago; J. F. Palmer, v.p.-sls., J&P Petroleum Projects, Dallas, Tex.; J. E. Scroggs, pres., Railway Techniques, Kansas City, Mo.; and J. W. Weber, trans.spec.-Portland Cement Asso., Skokie, Ill.



C. A. Hughes

Prestressed concrete can no longer properly be considered a new bridge material. The first prestressed bridge in the United States was constructed near Philadelphia in 1949, and the earliest railroad bridges were built in the late 1950's. In this somewhat more than 20 years of experience, engineers, and construction and maintenance men have learned much about this material; they have encountered many problems and have devised many ingenious solutions —and have also, naturally, made many mistakes.

Prestressed concrete is still by no means universally accepted for railroad bridges, but reluctance to adopt its use now seems to be based on economic considerations than on any doubts about its suitability. With its increasing cost advantage over steel for medium-span structures such as highway underpasses, and its continuing advantage of not requiring periodic repainting, surely more and more railroads in the future are going to accept, request, or adopt the use of this no longer exotic material.

Ten years ago this technology as applied to railroad structures in this country was in its infancy; today, the length of prestressed concrete bridge in service may well be measured in the hundreds of thousands of feet. It may, therefore, be of value at this time to briefly review the development of prestressed concrete railroad bridges over the past decade, and to discuss some

of the experiences and problems of those railroads which have adopted its use extensively.

Railroad bridges of prestressed concrete may be divided into two main categories: Those designed to be constructed under traffic, using railroad forces; and those built on a new line, or by use of a shoo-fly, which usually are constructed by contract.

Bridges built under traffic

Bridges constructed under traffic typically consist of precast, pretensioned box girders supported on driven pile bents. The piles may be either concrete, steel H-piles, or concrete-filled steel pipes. The cap may be precast, or cast -in-place.

Figure 1 is an example of one style of standard bridge, using double box girders and ballasted deck. The span is typically 25 to 30 ft, depending on the bent spacing of the timber trestle it is designed to replace. The girders weigh about 25 tons, and require a large capacity locomotive crane to handle and set them.

Figure 2 illustrates another type of standard bridge, which uses two single-box girders and has a timber open deck. This design has certain advantages, notably that the girders weigh only about half as much as a double-box design, and can be handled with a somewhat lighter machine. Also, the first cost is somewhat less than for a ballast-deck bridge. However, most railroads seem to feel that the disadvantage of having to maintain a timber open deck far outweighs these good points.

Some roads produce own girders

Several railroads having standard bridges similar to one of these order the prefabricated components in fairly large quantities—say a year's estimated requirements—thereby getting a more favorable price from the producer, and

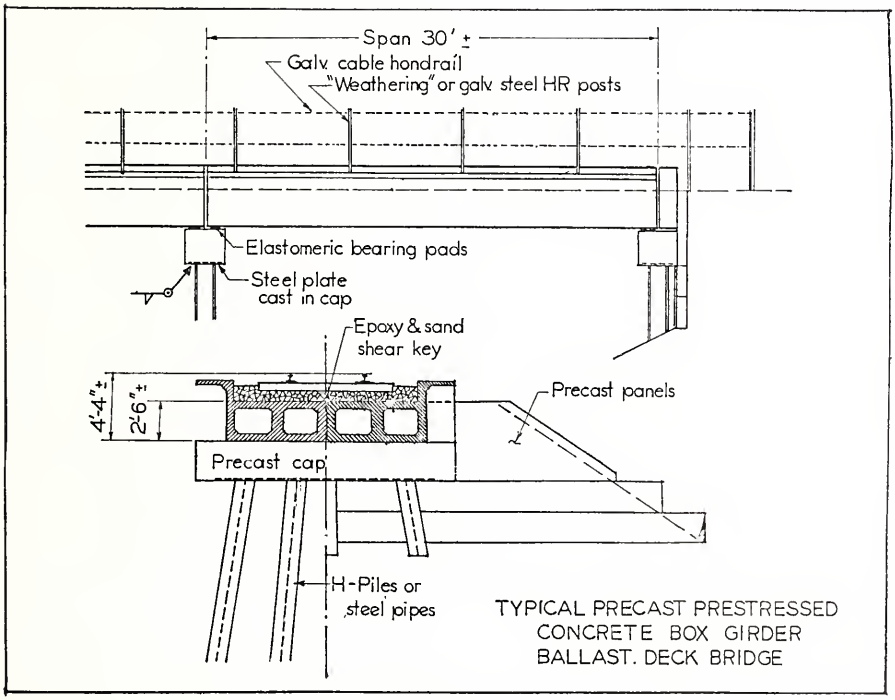


Fig. 1

allowing more flexibility in their own planning. Some railroads now produce their own conventionally reinforced concrete girders and probably some soon will be producing their own prestressed girders. Not only could a railroad probably produce its own prestressed concrete at a lower cost, but more importantly, could probably exercise much better quality control.

This is extremely important in a precast bridge, where many components must fit togther—girder ends must be plane and parallel to provide full bearing on the cap, dowel and bolt holes must be properly located to be usable, etc.—and many deviations from established tolerances are very difficult to detect in the field until the bridge is actually under construction. The man in the field usually compensates in some way or another for these imperfections, rather than rejecting the girder, since he usually has a track out of service and must use it. The cost in time and labor, however, may be all out of proportion to the actual magnitude of the dimensional error, and could be completely eliminated by the exercise of just a little more care on the part of the fabricator.

An added benefit to having standard items on hand is for use in emergencies. With the material on hand, it is often possible to construct a permanent replacement for a damaged bridge in less time than it would take to put in a temporary wood trestle or to drive falsework.

Locomotive crane deficiencies

A factor which has governed the design, and adoption of precast prestressed bridges by railroads for their own use is the capabilities of existing locomotive cranes and pile drivers, which are all designed either for building wood bridges or for handling scrap iron. Traditionally, locomotive cranes have not been equipped with such niceties as controlled load lowering, hy-

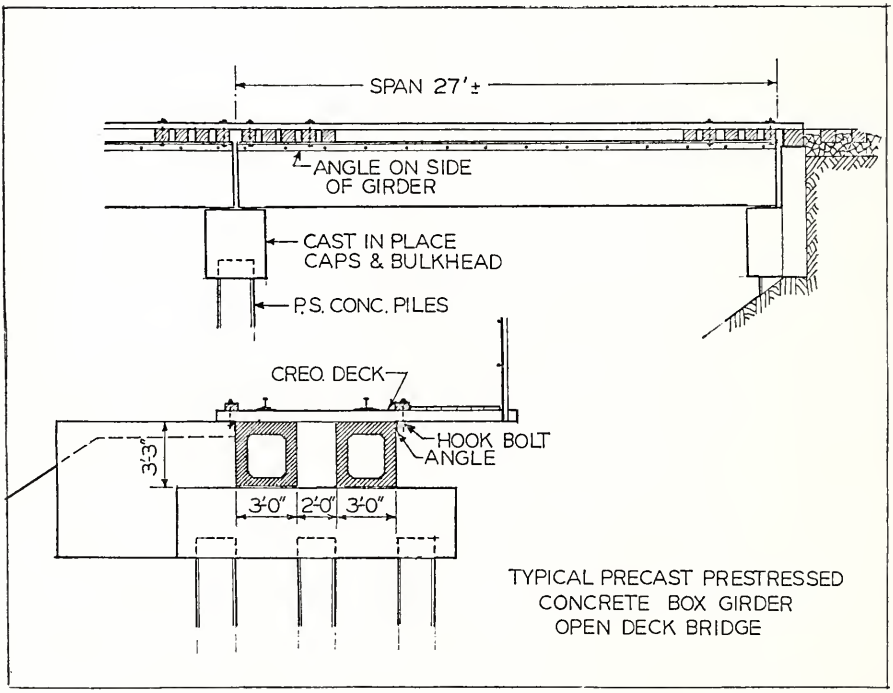


Fig. 2

draulic outriggers, or removable counterweights, which are almost standard on heavy truck cranes. They all have a relatively short wheel base, so if they are capable of setting a 25-ton girder ahead of themselves, the axles under the non-removable counterweight, when in configuration to move in a train, are heavier than most revenue loads. Some crane manufacturers have recently been made aware of these problems, and it remains to be seen if they can be economically and satisfactorily resolved within the framework of traditional locomotive crane design.

One point of agreement of all the railroads who have adopted prestressed concrete bridges is the definite superiority of the completed product to any other type of structure. The continued expenses of repair and replacement of a timber structure is eliminated, as is the ever-present hazard of fire. The periodic repainting required on a steel structure is unnecessary, and the necessity for finely detailed inspection and frequent minor repairs is eliminated. Most of the things that have gone wrong with concrete bridges have been due to external causes—any bridge will wash out if the water gets high enough, and in a derailment anything can happen. The concrete ballast deck bridge seems to have fared quite well in this respect so far — damaged walls and handrails may be considered minor compared to what probably would have happened to another type of structure.

Before proceeding to the other category of prestressed concrete bridges — those built off-line — it may be well to briefly consider the economics of adopting the standard type of prestressed bridge.

Three categories of charges

In making a comparison between using prestressed concrete for timber-trestle replacement and renewing in kind, three categories of charges or advantages must be considered: One, first cost; two, future expenses or savings; and three, the so-called intangibles — that is, such things as the relative risk of loss by fire or flood to which it is difficult to assign a dollar value.

The first cost of a prestressed concrete bridge is usually somewhat more than that of an open-deck timber trestle of minimum construction, but it may be very close to that of a first-class, creosoted timber ballast deck bridge. One significant difference in costs is that the material cost for any timber bridge is usually somewhat less, but the labor costs are usually much more than for a given number of men with equipment, more concrete bridge can be constructed in a given time interval.

The future charges include maintenance, future renewal, and depreciation. Depreciation is significant in that it acts as a tax shield, ultimately allowing recovery of about half of the initial investment.

When just the first cost and future charges for a specific bridge replacement are put on a common basis by any of the available economic techniques which recognize the time value of money, the comparison usually does not reveal any really clear-cut advantage to either alternative. Sometimes the change of just a couple of percentage points in the discount rate will completely reverse the whole situation.

Therefore, the decision to adopt prestressed concrete as a standard for wood-trestle replacement cannot be on a bare economic analysis of one bridge alone, but must rather consider the "intangible" benefits to the entire system: the reduced risk of interruption of service due to loss by fire or flood damage; the increased overload carrying capacity; and the ultimate drastic reduction of inspection and maintenance forces required for prestressed concrete compared to any other available type of construction.

It is probable that those railroads with a comparatively secure financial position and an optimistic conception of their future will ultimately adopt the more permanent structure, while those

whose operation is marginal will be forced to continue to use their available cash to perpetuate high-maintenance timber structures.

Structures built off line

Considering the other category of prestressed bridges—those built off-line —it is obvious that without the constraint of working between trains much greater freedom of design is possible, and longer spans are practical. These bridges may occasionally be built by the railroad, either in new construction or on a line change, but the great majority are freeway underpasses, and as such are usually designed by the various state highway departments, with the railroad checking their work.

The use of pre-tensioned precast box girders becomes impractical past the 70- to 80-ft span range; they simply become too heavy to transport and handle. They have been used, as shown in Figure 3, on spans up to 100 ft, but only in situations where time is an important element or the cost of poured-in-place concrete is exceptionally high. Apparently, economics usually favor some alternate type of construction.

One such alternate, shown in Figure 4, is the use of precast girders, either specially designed, or, more often, one of the various standard shapes. These are set in place individually, say five or six to a track, and a cast-in-place deck poured on top. This scheme eliminates the need for elaborate falsework, since the deck forms can be supported by the girders themselves, and, if the girders are of standard shape, may result in a very economical structure. The State of Texas, having a great variety of standard beams available, has made extensive use of this design. It results in a durable and handsome bridge, and apparently can be quite economical compared to alternate structures.

One disadvantage to this type of structure is its headroom requirements. With a girder 6 ft deep and the floor

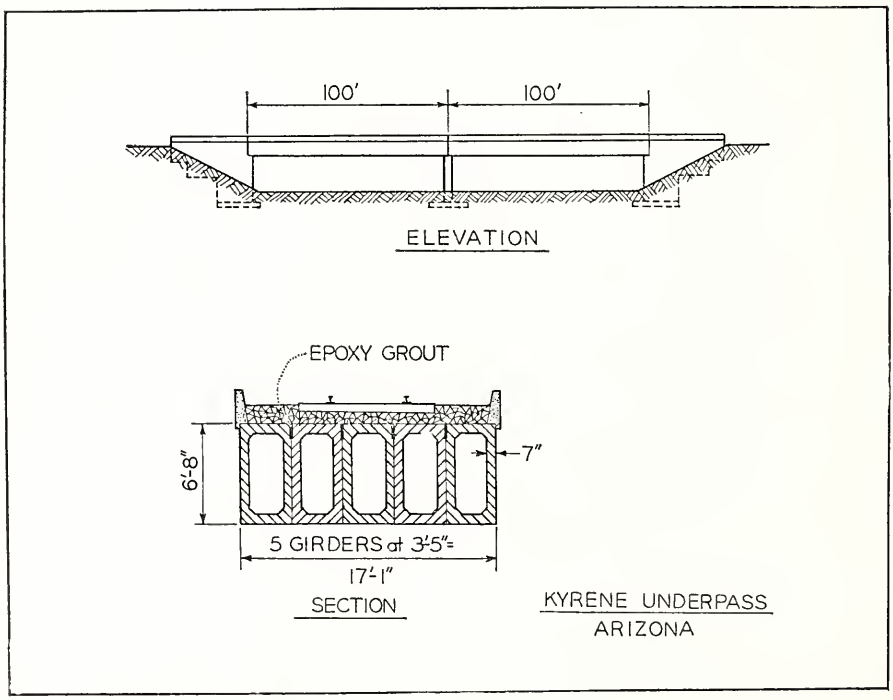


Fig. 3

and ballast section requiring about another 3 ft, depths below top of rail on the order of 9 or 10 ft may be required. In areas where the cost of grading and right of way are high, or drainage is a problem, each foot of headroom required may add considerably to the cost of the total project.

Apparently some people also object to this type of bridge as being too easy to understand. They don't want a bridge to obviously be of post-and-lintel construction. There are probably few railroad men who are offended by the sight of good sturdy girders supported by an honest cap sitting on stout, columns; but there are some people who would prefer to have these details disguised. It is true that a post-and-lintel bridge is not the ultimate in the expression of the plastic nature of concrete, but it does honestly — and sometimes beautifully — express the basic characteristics of a bridge, which are strength and integrity. It is probably beyond the scope of a report to the American Railway B&B Association to discuss the esthetics of bridge design, but by now most of us have surely seen things done under the current interpretation of esthetics that are revolting to us as bridge men: needlessly skewed and distorted piers; notched beams; elaborate shields to hide or disguise bridge bearings (and make inspectoin more difficult); and sometimes excessively applied ornamentation, including perhaps the ultimate in illogic, girders faced with ceramic tile!

Continuous design structures

An alternate solution to longer spans is the poured-in-place, post-tensioned girder. This is particularly more practical for skewed or curved bridges. In appearance, these may be very similar to the precast box-girder bridges, but there is one very significant difference. They are generally designed and constructed as continuous structures. Since these bridges typically cross several

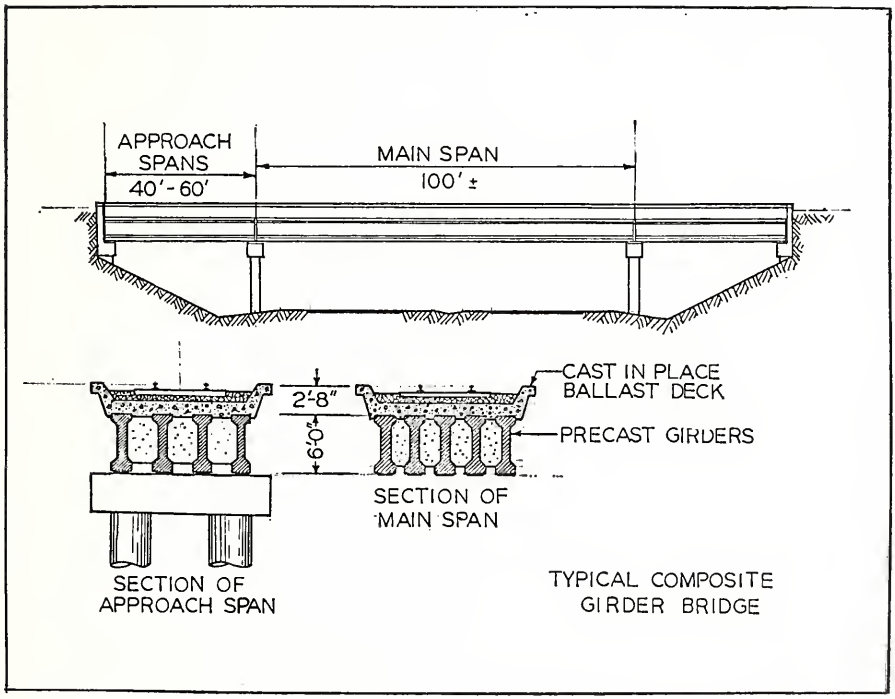


Fig. 4

traffic lanes in both directions and frequently have approach spans, they must be multiple-span bridges, but the techniques of post-tensioning require access to the ends of the beams; therefore, simple-span structures are practically impossible to construct.

Railroads have commonly avoided continuous structures in the past, and with good reasons: usually there is little economy to be realized from a continuous steel structure when the added complexity of erection and foundation construction is considered. Further, before the advent of the electronic computer, the analysis of a continuous structure for railway loadings was an almost heroic task, and the results were often viewed with a certain amount of skepticism.

However, times, techniques and materials change, and there are many advantages claimed for continuous structures other than the material savings and the relative ease of construction. The stiffer structure permits shallower sections for the same span and deflection as a simple span, thus gaining headroom, and the structure is more resistant to damage by derailment or earthquake. This last point may be debated: Although undoubtedly less apt to collapse completely, few of us would probably enjoy having to certify the safety of a continuous structure some dark and stormy night after a real good earthquake. It takes several highly specialized engineers several months with some very complicated machines to design one of these bridges, but a field engineer usually has only a few minutes to decide whether or not to run trains.

An example of a continuous post-tensioned box girder bridge is shown in Figure 5. This is a highway underpass in California, completed in 1971. The relative elevation of the highway and railroad here were such that the 8-ft, 8-inch depth was tolerable. The handrail detail was not specified by the railroad.

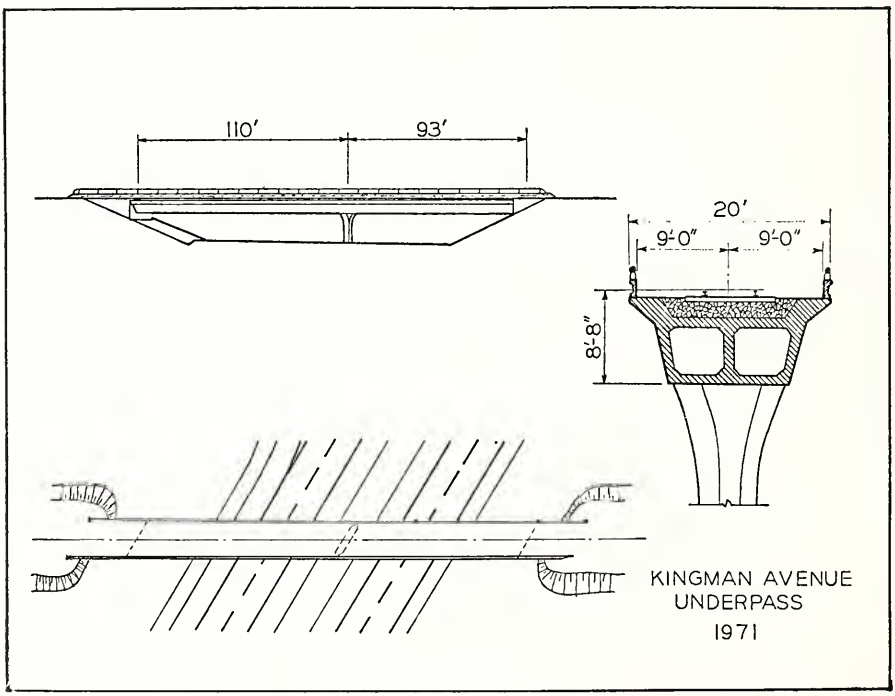


Fig. 5

Through-concrete-girder design

In many cases, headroom is quite limited and depths such as this can be very expensive to accommodate. This situation led to the development of the through-concrete-girder bridge, which, as far as is known, has been used in this country only in the State of California, with one small exception in Texas.

The design was originated by the Japanese National Railways prior to 1965, when they completed a double-track through-girder prestressed bridge across the Arakawa river, north of Tokyo. This bidge consists of four simple spans, each about 126 ft in length, with a depth below top of rail of less than 4 ft. Total depth of the girder is about eleven and one-quarter feet.

Before constructing the bridge, the Japanese conducted extensive mathematical analyses and model tests, the results of which were published in the journal of the "Permanent Way Society of Japan", No. 30. Although designed for a much lighter live load than that used in the United States, the fairly close correlation of their theoretical analyses and model studies to the action of the completed bridge does lend confidence to the general concept.

Girders of this type have been used as simple spans without encountering any particular problems which could be considered unique to this design configuration. The same is not true, however, of the continuous bridge of this shape, as shown in Figure 6.

This bridge, known as the Cordelia underpass, was designed by the California Highway Department as a part of a widening and upgrading project on Interstate 80 freeway. Due to grades on both the railroad and highway, headroom was limited, and the use of a structure with the minimum depth below the rail was indicated.

During design, there was special concern about the amount of loss of effective prestress force due to friction of the tendons against the conduit walls

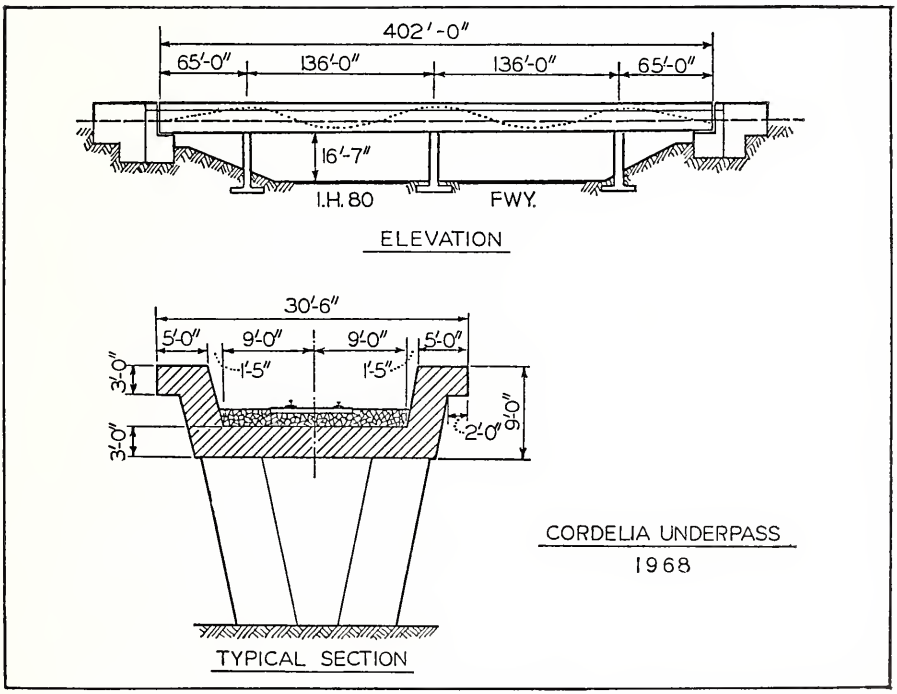


Fig. 6

in areas of curvature. Several steps were taken to reduce these friction losses, including use of rigid conduit and jacking from both ends. Estimates of the losses, however, were over-conservative: during prestressing, the ends of the girder were lifted from the abutments. As it was impractical then to reduce the prestress force, the amount of uplift required to produce the desired reactions was calculated, the girder jacked up at each end, and thicker bearing pads inserted.

Some problems with cracks

Two other interesting phenomena were observed after prestressing this bridge: Longitudinal cracks in the bottom of the girder near the center at the ends, and small, almost hair-line cracks in the top flange. The cracks in the bottom explained as due to a bursting effect produced by the high bearing stresses of the end anchorages of the prestressing tendons, and were avoided in future bridges by crossing some of the tendons near the ends and providing additional mild steel reinforcing grids. The cracks in the top flange, however, were not explained. They were most common at mid-span, where the concrete would be expected to be in compression. But they were small, so the worst were pressure grouted, and no particular steps were taken to prevent reoccurence in later designs.

The next bridge of this type to be constructed had some problems of its own. It carries an industrial track across a depressed freeway, with five spans ranging from 44 to 103 ft, and is built on a 13-deg, 30-min curve.

During prestressing, some of the tendons bulged out of the side of the web, not toward the center of the curve, as might be expected, but in exactly the opposite sense. This occurred over a pier where the tendons were curved sharply downward, and was caused by the collapse of one of the conduits due to the force of prestressing the tendons

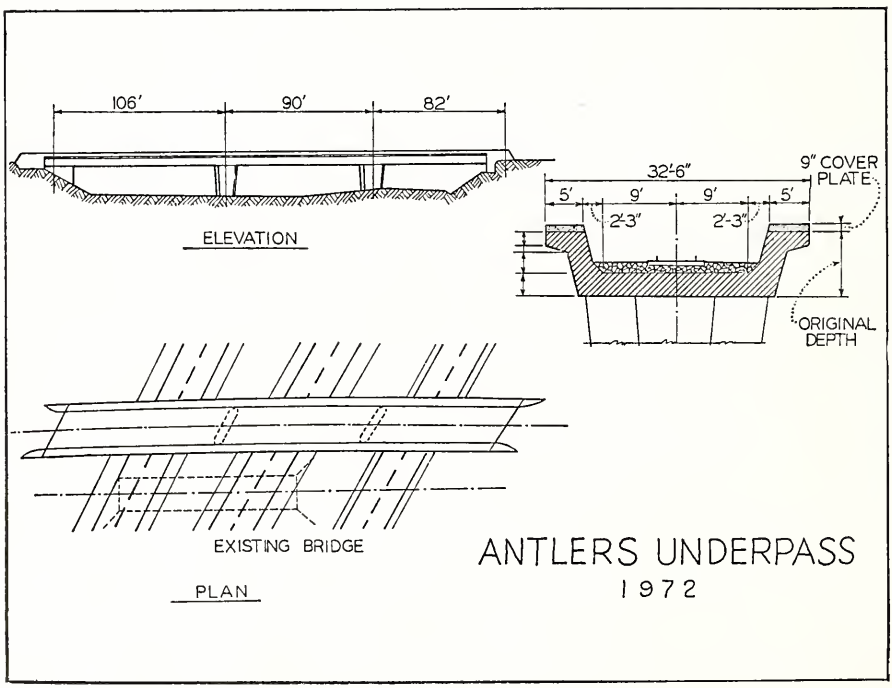


Fig. 7

above. Subsequent experimentation on full-size models led to adoption of minimum spacing requirements between conduits and minimum allowable radii of vertical curvature.

Again, small cracks occurred in the top flanges, mostly near mid-span. Some were large enough to allow moisture to pass through, staining the outside of the girder with white laitence. Again, no rational explanation could be found for these cracks in a compression zone, and they were ultimately sealed with a flexible compound to prevent entry of moisture.

The third through-girder bridge to be constructed was the Antlers underpass, shown in Figure 7. It also crossed a major freeway in northern California, carrying a main line track between San Francisco and Portland. It was constructed on a line change to eliminate an existing steel through-girder underpass. The floor of the girder was poured first, up to about sub-grade level. Then forms were continued for web and top flange, and these were poured together at a later date.

Shortly after pouring was complete, rather large cracks were noticed over the piers. These were considered to be of little importance since it was expected that they would close upon prestressing—which they did. But again, cracks were observed in the top flanges and web near midspan, in the compression zone, and larger in number and magnitude than any previously experienced. As this is in an area of rather high rainfall, it soon became apparent that water was running completely through several of these cracks, staining the outside of the web. This is a primary main line with no possibility of detour, and since the railroad expressed grave concern over a bridge that was so leaky, an attempt was made to seal the cracks by pressure grouting with epoxy.

The epoxy worked; it sealed the cracks, but soon new cracks began to appear alongside the old ones. Now various theories were brought forward to explain the origin of these cracks. One was differential shrinkage — since the floor had been poured first and had taken its initial shrinkage, it was now restraining the bottom of the web, but the top flange was free to shrink, and therefore develop tension cracks. Another was a thermal gradient developed between the relatively thin and exposed web and top flange and the more massive floor, which was also protected by the ballast section.

The general thesis of all these ideas was that the cracks were not structurally detrimental, but just that they must be sealed to protect the reinforcing steel. Accordingly, the new cracks were repumped with a different epoxy, with somewhat more success, and traffic was diverted to the new alignment. Under the slow speed necessitated by the new roadbed, the bridge appeared to function satisfactorily. However, after the roadbed had settled down and the speed had been increased, several of the cracks reopened, and the observed action of the bridge under traffic was definitely not up to main-line standards, so the railroad reverted to the old alignment, and the designers went back to the drawing board and computer.

After several months of analysis and re-analysis, involving several thousand dollars worth of high-speed computer time, it was agreed to be practical to reinforce the structure by casting a 9-inch thick, heavily reinforced cover plate on the top of each flange, bonded to the existing concrete with a multitude of dowels grouted into drilled holes. The structure was instrumented to measure deflections and strains in the new reinforcement, and two heavily loaded ballast cars which had been set over by crane from the main track, were used to simulate live loading. Since there was very close agreement between the computed and observed deflections and strains, indicating the structure was acting as anticipated, the railroad agreed to resume operation over it. It has been in service under

full-speed operation for several months now, and seems to be behaving as a main-line bridge should.

The ultimate answer to the cause of these cracks has not yet been found, however. A bridge of similar design, which was in the early stages of construction at the time of the Antlers problems, was modified by placing additional mild steel reinforcement in the top flanges, and the pour schedule was adjusted to minimize the effects of differential shrinkage. The cracks still occurred—not so many, but significantly, in the same general area and with the same pattern of occurrence—cracks over the piers appeared soon after pouring was completed, which closed during prestressing, at which time the now familiar cracks appeared at mid-span. A consulting engineer suggested that they might be caused by slight falsework settlement during construction. This would result in the initial cracks observed over the piers, which in closing during the prestressing allow unexpected additional upward rotation at the piers, causing uplift at mid-span and consequent tension in the top flange.

There is one of these bridges presently in the late stages of design which is scheduled to begin construction within about a year. At the insistence of, and with some assistance from the railroad, this structure will be fully instrumented to provide detailed knowledge of the strains present at all stages of construction. When the results of this testing become generally available, the use of this type of bridge, with its many advantages both to the state highway departments and to the railroads, will probably become much more widespread.

Your committee hopes that this brief resume of the early years of the use of prestressed concrete for railway bridges has been interesting, and even more that it has been reassuring. Certainly, this material has now come of age, not of course without some growing pains, and the future is sure to bring a fuller realization of its mature qualities of economy, durability, and beauty.

HISTORICAL INFORMATION

List of Annual Conventions

No.	Place of Meeting	Date	Membership
1	St. Louis, Mo.	Sept. 25, 1891	60
2	Cincinnati, Ohio	Oct. 18-19, 1892	112
3	Philadelphia, Pa.	Oct. 17-19, 1893	128
4	Kansas City, Mo.	Oct. 16-18, 1894	115
5	New Orleans, La.	Oct. 15-16, 1895	122
6	Chicago, Ill.	Oct. 20-22, 1896	140
7	Denver, Colo.	Oct. 19-21, 1897	127
8	Richmond, Va.	Oct. 18-19, 1898	148
9	Detroit, Mich.	Oct. 17-19, 1899	148
10	St. Louis, Mo.	Oct. 16-18, 1900	143
11	Atlanta, Ga.	Oct. 15-17, 1901	171
12	Minneapolis, Minn.	Oct. 21-23, 1902	195
13	Quebec, Canada	Oct. 20-22, 1903	223
14	Chicago, Ill.	Oct. 18-20, 1904	293
15	Pittsburgh, Pa.	Oct. 17-19, 1905	313
16	Boston, Mass	Oct. 16-18, 1906	340
17	Milwaukee, Wis.	Oct. 15-17, 1907	341
18	Washington, D. C.	Oct. 20-22, 1908	368
19	Jacksonville, Fla.	Oct. 19-21, 1909	393
20	Denver, Colo.	Oct. 18-20, 1910	428
21	St. Louis, Mo.	Oct. 17-19, 1911	499
22	Baltimore, Md.	Oct. 15-17, 1912	524
23	Montreal, Quebec	Oct. 21-23, 1913	570
24	Los Angeles, Cal.	Oct. 20-22, 1914	586
25	Detroit, Mich.	Oct. 19-21, 1915	665
26	New Orleans. La.	Oct. 17-19, 1916	710
27	Chicago, Ill.	Oct. 16-18, 1917	704
28	Chicago, Ill.	Oct. 15-17, 1918	716
29	Cleveland, Ohio	Oct. 21-23, 1919	776
30	Atlanta, Ga.	Oct. 26-28, 1920	840
31	New York, N. Y.	Oct. 18-20, 1921	850
32	Cincinnati, Ohio	Oct. 17-19, 1922	865
33	Seattle, Wash.	Oct. 16-18, 1923	846
34	Kansas City, Mo.	Oct. 21-23, 1924	837
35	Buffalo, N. Y.	Oct. 20-22, 1925	759
36	Richmond, Va.	Oct. 12-14, 1926	750
37	Minneapolis, Minn.	Oct. 18-20, 1927	754
38	Boston, Mass.	Oct. 23-25, 1928	755
39	New Orleans, La.	Oct. 15-17, 1929	755
40	Louisville, Ky.	Oct. 21-23, 1930	713
41	Chicago, Ill.	Oct. 16-18, 1934	592
42	Chicago, Ill.	Oct. 15-17, 1935	547
43	Chicago, Ill.	Oct. 20-22, 1936	588
44	Chicago, Ill.	Oct. 19-21, 1937	566
45	Chicago, Ill.	Oct. 18-20, 1938	589
46	Chicago, Ill.	Oct. 17-19, 1939	546
47	Chicago, Ill.	Oct. 15-17, 1940	610
48	Chicago, Ill.	Oct. 14-16, 1941	594
49	Chicago, Ill.	Oct. 20-22, 1942	618
50	Chicago, Ill.	Oct. 20-21, 1943	597

No.	Place of Meeting	Date	Membership
51	Chicago, Ill.	Sept. 17-19, 1946	698
52	Chicago, Ill.	Sept. 16-18, 1947	651
53	Chicago, Ill.	Sept. 20-22, 1948	652
54	Chicago, Ill.	Sept. 12-14, 1949	676
55	Chicago, Ill.	Sept. 18-20, 1950	713
56	Chicago, Ill.	Sept. 17-19, 1951	676
57	Chicago, Ill.	Sept. 15-17, 1952	667
58	Chicago, Ill.	Sept. 15-17, 1953	666
59	Chicago, Ill.	Sept. 13-15, 1954	682
60	Chicago, Ill.	Sept. 19-21, 1951	625
61	Chicago, Ill.	Sept. 18-20, 1956	657
62	Chicago, Ill.	Sept. 23-25, 1957	769
63	Chicago, Ill.	Sept. 15-17, 1958	828
64	Chicago, Ill.	Sept. 15-17, 1959	863
65	Chicago, Ill.	Sept. 19-21, 1960	932
66	Chicago, Ill.	Sept. 18-20, 1961	968
67	Chicago, Ill.	Sept. 10-12, 1962	942
68	Chicago, Ill.	Oct. 14-16, 1963	887
69	Chicago, Ill.	Sept. 14-16, 1964	860
70	Chicago, Ill.	Sept. 13-15, 1965	829
71	Chicago, Ill.	Sept. 26-28, 1966	800
72	Chicago, Ill.	Oct. 11-13, 1967	799
73	Chicago, Ill.	Sept. 9-11, 1968	825
74	Chicago, Ill.	Sept. 9-11, 1969	746
75	Chicago, Ill.	Sept. 28-30, 1970	709
76	Chicago, Ill.	Sept. 13-15, 1971	719
77	Chicago, Ill.	Sept. 18-20, 1972	706

Past Officers

	1891-1892	1892-1893	1893-1894	1894-1895
President	O. J. Travis	H. M. Hall	J. E. Wallace	Geo. W. Andrews
1st V.-Pres.	H. M. Hall	J. E. Wallace	Geo. W. Andrews	W. A. McGonagle
2nd V.-Pres.	J. B. Mitchell	G. W. Hinman	W. A. McGonagle	L. K. Spafford
3rd V.-Pres.	James Stannard	N. W. Thompson	L. K. Spafford	James Stannard
4th V.-Pres.	G. W. Hinman	C. T. Fuller	E. D. Hines	Walter G. Berg
Secretary	C. W. Gooch	S. F. Patterson	S. F Patterson	S. F. Patterson
Treasurer	George M. Reid	George M. Reid	George M. Reid	George M. Reid
Executive Members	W. R. Damon	G. W. Andrews	Q. McNab	James Stannard
	G. W. Markley	J. M. Staten	A. S. Markley	James H. Travis
	W. A. McGonagle	J. M. Caldwell	Floyd Ingram	J. H. Cummin
	C. W. McGehee	Q. McNab	James Stannard	R. M. Peck
	G. W. Turner	Floyd Ingram	James H. Travis	J. L. White
	J. E. Wallace	A. S. Markley	J. H. Cummin	A. Shane

	1895-1896	1896-1897	1897-1898	1898-1899
President	W. A. McGonagle	James Stannard	Walter G. Berg	J. M. Cummin
1st V.-Pres.	L. K. Spafford	Walter G. Berg	J. H. Cummin	A. S. Markley
2nd V.-Pres.	James Stannard	J. H. Cummin	A. S. Markley	C. C. Mallard
3rd V.-Pres.	Walter G. Berg	A. S. Markley	G. W. Hinman	W. A. Rogers
4th V.-Pres.	J. H. Cummin	R. M. Peck	C. C. Mallard	J. M. Staten
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	George M. Reid	N. W. Thompson	N. W. Thompson	N. W. Thompson
Executive Members	R. M. Peck	W. O. Eggleston	G. J. Bishop	Wm. S. Danes
	L. J. White	W. M. Noon	C. P. Austin	J. H. Markley
	A. Shane	J. M. Staten	M. Riney	W. O. Eggleston
	A. S. Markley	G. J. Bishop	Wm. S. Danes	R. L. Heflin
	W. M. Noon	C. P. Austin	J. H. Markley	F. W. Tanner
	J. M. Staten	M. Riney	W. O. Eggleston	A. Zimmerman

	1899-1900	1900-1901	1901-1902	1902-1903
President	Aaron S. Markley	W. A. Rogers	W. S. Danes	B. F. Pickering
1st V.-Pres.	W. A. Rogers	W. S. Danes	B. F. Pickering	C. C. Mallard
2nd V.-Pres.	J. M. Staten	B. G. Pickering	A. Shane	A. Shane
3rd V.-Pres.	Wm. S. Danes	A. Shane	A. Zimmerman	A. Zimmerman
4th V.-Pres.	B. F. Pickering	A. Zimmerman	C. C. Mallard	A. Montzheimer
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	N. W. Thompson	N. W. Thompson	N. W. Thompson	N. W. Thompson
Executive Members	T. M. Strain	T. M. Strain	A. Montzheimer	W. E. Smith
	R. L. Heflin	H. D. Cleaveland	W. E. Smith	A. W. Merrick
	F. W. Tanner	F. W. Turner	A. W. Merrick	C. P. Austin
	A. Zimmerman	A. Montzheimer	C. P. Austin	C. A. Lichty
	H. D. Cleaveland	W. E. Smith	C. A. Lichty	W. O. Eggleston
	A. Montzheimer	A. W. Merrick	W O. Eggleston	J. H. Markley

	1903-1904	1904-1905	1905-1906	1906-1907
President	A. Montzheimer	C. A. Lichty	J. B. Sheldon	J. H. Markley
1st V.-Pres.	A. Shane	J. B. Sheldon	J. H. Markley	R. H. Reid
2nd V.-Pres.	C. A. Lichty	J. H. Markley	R. H. Reid	J. P. Canty
3rd V.-Pres.	J. B. Sheldon	R. H. Reid	R. C. Sattley	H. Rettinghouse
4th V.-Pres.	J. H. Markley	R. C. Sattley	J. P. Canty	F. E. Schall
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	C. P. Austin	C. P. Austin	C. P. Austin	C. P. Austin
Executive Members	R. H. Reid	W. O. Eggleston	H. Rettinghouse	W. O. Eggleston
	W. O. Eggleston	A. E. Killam	A. E. Killam	A. E. Killam
	A. E. Killam	H. Rettinghouse	J. S. Lemond	J. S. Lemond
	R. C. Sattley	J. S. Lemond	C. W. Richey	C. W. Richey
	H. Rettinghouse	W. H. Finley	W. O. Eggleston	H. H. Eggleston
	J. S. Lemond	C. W. Richey	F. E. Schall	B. J. Sweatt

	1907-1908	1908-1909	1909-1910	1910-1911
President	R. H. Reid	J. P. Canty	H. Rettinghouse	H. Rettinghouse
1st V.-Pres.	J. P. Canty	H. Rettinghouse	J. S. Lemond	F. E. Schall
2nd V.-Pres.	H. Rettinghouse	F. E. Schall	F. E. Schall	A. E. Killam
3rd V.-Pres.	F. E. Schall	J. S. Lemond	A. E. Killam	J. N. Penwell
4th V.-Pres.	W. O. Eggleston	A. E. Killam	J. N. Penwell	L. D. Hadwen
Secretary	S. F. Patterson	S. F. Patterson	C. A. Lichty	C. A. Lichty
Treasurer	C. P. Austin	C. P. Austin	J. P. Canty	J. P. Canty
Executive Members	A. E. Killam	J. N. Penwell	W. Beahan	T. J. Fullem
	J. S. Lemond	Willard Beahan	F. B. Scheetz	G. Aldrich
	C. W. Richey	F. B. Scheetz	L. D. Hadwen	P. Swenson
	T. S. Leake	W. H. Finley	T. J. Fullem	C. W. Rear
	W. H. Finley	L. D. Hadwen	G. Aldrich	W. O. Eggleston
	J. N. Penwell	T. J. Fullem	P. Swenson	W. F. Steffens

	1911-1912	1912-1913	1913-1914	1914-1915
President	F. E. Schall	A. E. Killam	J. N. Penwell	L. D. Hadwen
1st V.-Pres.	A. E. Killam	J. N. Penwell	L. D. Hadwen	G. Aldrich
2nd V.-Pres.	J. N. Penwell	L. D. Hadwen	G. Aldrich	G. W. Rear
3rd V.-Pres.	L. D. Hadwen	T. J. Fullem	G. W. Rear	C. E. Smith
4th V.-Pres.	T. J. Fullen	G. Aldrich	C. E. Smith	E. B. Ashby
Secretary	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Treasurer	J. P. Canty	J. P. Canty	J. P. Canty	F. E. Weise
Executive Members	G. Aldrich	G. W. Rear	W. F. Steffens	W. F. Steffens
	P. Swenson	W. F. Steffens	E. B. Ashby	S. C. Tanner
	G. W. Rear	E. B. Ashby	S. C. Tanner	Lee Jutton
	W. F. Steffens	C. E. Smith	Lee Jutton	F. F. Strouse
	E. B. Ashby	S. C. Tanner	W. F. Strouse	C. R. Knowles
	W. O. Eggleston	Lee Jutton	C. R. Knowles	A. Ridgway

	1915-1916	1916-1917	1917-1918	1918-1919
President	G. W. Rear	C. E. Smith	S. C. Tanner	Lee Jutton
1st V.-Pres.	C. E. Smith	E. B. Ashby	Lee Jutton	F. E. Weise
2nd V.-Pres.	E. B. Ashby	S. C. Tanner	F. E. Weise	W. F. Strouse
3rd V.-Pres.	S. C. Tanner	Lee Jutton	W. F. Strouse	C. R. Knowles
4th V.-Pres.	Lee Jutton	F. E. Weise	C. R. Knowles	A. Ridgway
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Executive Members	F. E. Weise	W. F. Strouse	A. Ridgway	J. S. Robinson
	W. F. Strouse	C. R. Knowles	J. S. Robinson	J. P. Wood
	C. R. Knowles	A. Ridgway	J. P. Wood	A. B. McVay
	A. Ridgway	J. S. Robinson	D. C. Zook	J. H. Johnston
	J. S. Robinson	J. P. Wood	A. B. McVay	E. T. Howson
	J. P. Wood	D. C. Zook	J. H. Johnston	C. W. Wright

	1919-1920	1920-1921	1921-1922	1922-1923
President	F. E. Weise	W. F. Strouse	C. R. Knowles	Arthur Ridgway
1st V.-Pres.	W. F. Strouse	C. R. Knowles	A. Ridgway	J. P. Wood
2nd V.-Pres.	C. R. Knowles	A. Ridgway	J. S. Robinson	J. S. Robinson
3rd V.-Pres.	A. Ridgway	J. S. Robinson	J. P. Wood	C. W. Wright
4th V.-Pres.	J. S. Robinson	J. P. Wood	C. W. Wright	E. T. Howson
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.			F. E. Weise	F. E. Weise
Directors	J. P. Wood	C. W. Wright	E. T. Howson	F. C. Baluss
	A. B. McVay	A. B. McVay	J. H. Johnston	Maro Johnson
	J. H. Johnston	G. A. Manthey	E. K. Barrett	O. F. Dalstrom
	E. T. Howson	E. T. Howson	F. C. Baluss	S. D. Corey
	C. W. Wright	J. H. Johnston	Maro Johnson	W. B. Hotson
	G. A. Manthey	E. K. Barrett	O. F. Dalstrom	P. N. Nelson

	1923-1924	1924-1925	1925-1926	1926-1927
President	J. S. Robinson	J. P. Wood	C. W. Wright	E. T. Howson
1st V.-Pres.	J. P. Wood	C. W. Wright	E. T. Howson	F. C. Baluss
2nd V.-Pres.	C. W. Wright	E. T. Howson	F. C. Baluss	Maro Johnson
3rd V.-Pres.	E. T. Howson	F. C. Baluss	Maro Johnson	J. S. Huntoon
4th V.-Pres.	F. C. Baluss	Maro Johnson	J. S. Huntoon	C. S. Heritage
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.	F. E. Weise	F. E. Weise	F. E. Weise	F. E. Weise
Directors	S. T. Corey	J. S. Huntoon	C. S. Heritage	A. I. Gauthier
	W. B. Hotson	A. I. Gauthier	W. B. Hotson	E. L. Sinclair
	P. N. Nelson	E. L. Sinclair	P. N. Nelson	P. F. Dalstrom
	J. S. Huntoon	C. S. Heritage	A. I. Gauthier	W. T. Krausch
	A. I. Gauthier	W. B. Hotson	E. L. Sinclair	R. C. Bardwell
	E. L. Sinclair	P. N. Nelson	O. F. Dalstrom	H. I. Benjamin

	1927-1928	1928-1929	1929-1930	1930-1934
President	F. C. Baluss	Maro Johnson	J. S. Huntoon	C. S. Heritage
1st V.-Pres.	Maro Johnson	J. S. Huntoon	C. S. Heritage	A. I. Gauthier
2nd V.-Pres.	J. S. Huntoon	C. S. Heritage	A. I. Gauthier	H. I. Benjamin
3rd V.-Pres.	C. S. Heritage	A. I. Gauthier	H. I. Benjamin	W. T. Krausch
4th V.-Pres.	A. I. Gauthier	H. I. Benjamin	W. T. Krausch	T. H. Strate
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.	F. E. Weise	F. E. Weise		
Directors	W. T. Krausch	R. C. Henderson	G. A. Rodman	E. C. Neville
	R. C. Bardwell	J. S. Ekey	W. A. Batey	H. H. Best
	H. I. Benjamin	T. H. Strate	F. W. Hillman	J. E. King
	R. C. Henderson	G. A. Rodman	E. C. Neville	A. B. Scowden
	T. H. Strate	W. A. Batey	H. H. Best	W. A. Batey
	J. S. Ekey	F. W. Hillman	J. E. King	L. C. Smith

	1934-1935	1935-1936	1936-1937	1937-1938
President	H. I. Benjamin	T. H. Strate	E. C. Neville	C. M. Burpee
1st V.-Pres.	T. H. Strate	E. C. Neville	C. M. Burpee	F. H. Masters
2nd V.-Pres.	E. C. Neville	C. M. Burpee	F. H. Masters	W. S. Lacher
3rd V.-Pres.	A. B. Scowden	F. H. Masters	C. A. J. Richards	C. A. J. Richards
4th V.-Pres.	W. R. Roof	C. A. J. Richards	W. S. Lacher	F. H. Cramer
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Directors	C. M. Burpee	A. L. McCloy	W. R. Roof	B. R. Meyers
	W. A. Batey	R. P. Luck	T. P. Soule	G. S. Crites
	L. C. Smith	H. H. Best	F. H. Cramer	R. E. Dove
	C. A. J. Richards	W. R. Roof	B. R. Meyers	T. P. Soule
	A. L. McCoy	T. P. Soule	G. S. Crites	A. Chinn
	R. P. Luck	F. H. Cramer	R. E. Dove	L. G. Byrd

	1938-1939	1939-1940	1940-1941	1941-1942
President	Armstrong Chinn	A. E. Bechtelheimer	H. M. Church	R. E. Dove
1st V.-Pres.	F. H. Cramer	F. H. Cramer	R. E. Dove	F. H. Soothill
2nd V.-Pres.	A. E. Bechtelheimer	H. M. Church	F. A. Soothill	G. S. Crites
3rd V.-Pres.	H. M. Church	R. E. Dove	G. S. Crites	A. M. Knowles
4th V.-Pres.	R. E. Dove	F. H. Soothill	A. M. Knowles	N. D. Howard
Sec.-Treas.	C. A. Lichty	C. A. Lichty		
Secretary	.....	.....	F. O. Whiteman	A. G. Shaver
Treasurer	.....	.....	F. E. Weise	F. E. Weise
Directors	L. G. Byrd	B. R. Meyers	N. D. Howard	R. E. Caudle
	W. R. Ganser	W. Walkden	L. G. Byrd	I. A. Moore
	F. H. Soothill	A. S. Krefting	K. L. Miner	W. A. Sweet
	B. R. Meyers	A. M. Knowles	R. E. Caudle	J. L. Varker
	W. Walkden	L. G. Byrd	I. A. Moore	L. E. Peyser
	A. S. Krefting	K. L. Miner	W. A. Sweet	Martin Meyer

	1942-1943	1943-1944	1944-1945	1945-1946
President	G. S. Crites	J. L. Varker	J. L. Varker	N. D. Howard
1st V.-Pres.	R. E. Caudle	R. E. Caudle	R. E. Caudle	F. G. Campbell
2nd V.-Pres.	A. M. Knowles	N. D. Howard	N. D. Howard	J. S. Hancock
3rd V.-Pres.	N. D. Howard	F. G. Campbell	F. G. Campbell	E. H. Barnhart
4th V.-Pres.	J. L. Varker	J. S. Hancock	J. S. Hancock	W. F. Martens
Secretary	A. G. Shaver† Lorene Kindred‡ Elinor V. Heffern	Elinor V. Heffern	Elise LaChance	Elise LaChance
Treasurer	F. E. Weise	C. R. Knowles	C. R. Knowles	C. R. Knowles
Treasurer Emeritus		F. E. Weise	F. E. Weise	
Directors	M. Meyer	W. F. Martens	W. F. Martens	A. B. Chapman
	L. E. Peyser	A. L. McCloy	A. L. McCloy	W. A. Huckstep
	K. L. Miner	L. C. Winkelhaus	L. C. Winkelhaus	F. R. Spofford
	F. G. Campbell	E. H. Barnhart	E. H. Barnhart	Guy E. Martin
	J. S. Hancock	A. B. Chapman	A. B. Chapman	B. R. Meyers
	L. C. Winkelhaus	L. E. Peyser	L. E. Peyser	L. E. Peyser

† To November 1, 1962 ‡ To February 1, 1943

	1946-1947	1947-1948	1948-1949	1949-1950
President	F. G. Campbell	J. S. Hancock	E. H. Barnhart	W. F. Martens
1st V.-Pres.	J. S. Hancock	E. H. Barnhart	W. F. Martens	W. A. Huckstep
2nd V.-Pres.	E. H. Barnhart	W. F. Martens	W. A. Huckstep	Guy E. Martin
3rd V.-Pres.	W. F. Martens	W. A. Huckstep	Guy E. Martin	F. R. Spofford
4th V.-Pres.	W. A. Huckstep	G. E. Martin	F. R. Spofford	Lee Mayfield
Treasurer	Elise LaChance	Elise LaChance	Elise LaChance	Elise LaChance
Treasurer	C. R. Knowles	C. R. Knowles	L. C. Winkelhaus	L. C. Winkelhaus
Directors	Guy E. Martin	H. M. Harlow	Lee Mayfield	H. M. Harlow
	B. R. Meyers	H. B. Christianson	F. M. Misch	V. E. Engman
	L. E. Peyser	F. R. Spofford	W. D. Gibson	G. W. Benson
	H. M. Harlow	Lee Mayfield	H. M. Harlow	F. M. Misch
	H. B. Christianson	Franz M. Misch	V. E. Engman	L. R. Morgan
	F. R. Spofford	W. D. Gibson	G. W. Benson	J. A. Jorlett

	1950-1951	1951-1952	1952-1953	1953-1954
President	W. A. Huckstep	Guy E. Martin	F. R. Spofford	Lee Mayfield
1st V.-Pres.	Guy E. Martin	F. R. Spofford	Lee Mayfield	H. M. Harlow
2nd V.-Pres.	F. R. Spofford	Lee Mayfield	H. M. Harlow	J. A. Jorlett
3rd V.-Pres.	Lee Mayfield	H. M. Harlow	J. A. Jorlett	R. R. Gunderson
4th V.-Pres.	H. M. Harlow	J. A. Jorlett	R. R. Gunderson	W. H. Huffman
Secretary	Elise LaChance	Elise LaChance	Elise LaChance	Elise LaChance
Treasurer	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus
Directors	F. M. Misch	M. H. Dick	W. H. Huffman	M. H. Dick
	L. R. Morgan	R. R. Gunderson	L. R. Morgan	J. F. Warrenfells
	J. A. Jorlett	J. F. Warrenfells	B. M. Stephens	G. Switzer
	M. H. Dick	W. H. Huffman	M. H. Dick	B. M. Stephens
	R. R. Gunderson	L. R. Morgan	J. F. Warrenfells	W. H. Bunge
	J. F. Warrenfells	B. M. Stephens	G. Switzer	E. R. Schlaf

	1954-1955	1955-1956	1956-1957	1957-1958
President	H. M. Harlow	J. A. Jorlett	R. R. Gunderson	W. H. Huffman
1st V.-Pres.	J. A. Jorlett	R. R. Gunderson	W. H. Huffman	M. H. Dick
2nd V.-Pres.	R. R. Gunderson	W. H. Huffman	M. H. Dick	B. M. Stephens
3rd V.-Pres.	W. H. Huffman	M. H. Dick	B. M. Stephens	H. D. Curie
4th V.-Pres.	M. H. Dick	B. M. Stephens	H. D. Curie	
Secretary	Elise LaChance	Elise LaChance	Elise LaChance	Elise LaChance
Treasurer	L. C. Winkelhause	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus
Directors	B. M. Stephens	J. F. Warrenfells	W. H. Bunge	G. W. Benson
	W. H. Bunge	H. D. Curie	E. R. Schlaf	J. M. Lowry
	E. R. Schlaf	J. M. Lowry	G. W. Benson	H. H. Matthews
	J. F. Warrenfells	W. H. Bunge	J. M. Lowry	T. M. von Sprecken
	H. D. Curie	E. R. Schlaf	T. M. von Sprecken	W. H. Bunge
	J. M Lowry	G. W. Benson	H. A. Matthews	E. R. Schlaf

	1958-1959	1959-1960	1960-1961	1961-1962
President	M. H. Dick	B. M. Stephens	H. D. Curie	G. W. Benson
1st V.-Pres.	B. M. Stephens	H. D. Curie	G. W. Benson	J. M. Lowry
2nd V.-Pres.	H. D. Curie	G. W. Benson	J. M. Lowry	E. R. Schlaf
3rd V.-Pres.	G. W. Benson	J. M. Lowry	E. R. Schlaf	H. A. Matthews
Secretary	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg
Treasurer	L. C. Winkelhaus	L. C. Winkelhause	L. C. Winkelhaus	L. C. Winkelhause
Directors	J. M. Lowry	W. H. Bunge	H. A. Matthews	R. C. Baker
	R. C. Baker	E. R. Schlaf	M. J. Hubbard	R. H. Miller
	W. H. Bunge	H. A. Matthews	R. C. Baker	Shirley White
	E. R. Schlaf	M. J. Hubbard	R. H. Miller	H. M. Wilson
	H. A. Matthews	R. C. Baker	Shirley White	R. D. Hellweg
	M. J. Hubbard	R. H. Miller	H. M. Wilson	F. W. Hutcheson

	1962-1963	1963-1964	1964-1965	1965-1966
President	J. M. Lowry	E. R. Schlaf	R. C. Baker	H. M. Wilson
1st V.-Pres.	E. R. Schlaf	R. C. Baker	H. M. Wilson	R. D. Hellweg
2nd V.-Pres.	H. A. Matthews	Shirley White	R. D. Hellweg	J. W. DeValle
3rd V.-Pres.	R. C. Baker	H. M. Wilson	J. W. DeValle	W. F. Armstrong
Secretary	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg
Treasurer	L. C. Winkelhaus	E. F. Snyder	E. F. Snyder	E. F. Snyder
Directors	Shirley White	R. D. Hellweg	W. F. Armstrong	J. A. Goforth
	H. M. Wilson	F. W. Hutcheson	J. S. Ellis	E. R. Simmons
	R. D. Hellweg	W. F. Armstrong	J. A. Goforth	N. D. Bryant
	F. W. Hutcheson	J. W. DeValle	E. R. Simmons	A. R. Dahlberg
	W. F. Armstrong	J. A. Goforth	N. D. Bryant	J. S. Ellis
	J. W. DeValle	E. R. Simmons	A. R. Dahlberg	T. L. Fuller

	1966-1967	1967-1968	1968-1969	1969-1970
President	R. D. Hellweg	J. W. DeValle	W. F. Armstrong	J. A. Goforth
1st V.-Pres.	J. W. DeValle	W. F. Armstrong	J. A. Goforth	A. R. Dahlberg
2nd V.-Pres.	W. F. Armstrong	J. A. Goforth	A. R. Dahlberg	T. L. Fuller
3rd V.-Pres.	J. A. Goforth	A. R. Dahlberg	T. L. Fulle	N. D. Bryant
Secretary	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg
Treasurer	W. H. Huffman	W. H. Huffman	W. H. Huffman	W. H. Huffman
Directors	N. D. Bryant	J. S. Ellis	N. F. Lucas	W. H. Rankin
	A. R. Dahlberg	T. L. Fuller	W. L. Short	E. E. Runde
	H. F. Lucas	R. A. Youngblood	C. E. Wachter	T. A. Reynolds
	J. S. Ellis	H. F. Lucas	A. C. Jones	J. J. Ridgeway
	T. L. Fuller	W. L. Short	W. H. Rankin	J. R. Williams
	R. A. Youngblood	C. E. Wachter	E. E. Runde	J. W. Chambers
	V. D. Raessler	A. C. Jones	T. A. Reynolds	R. E. Frame
	W. L. Short	W. H. Rankin	J. J. Ridgeway	J. C. Hobbs
	C. E. Wachter	E. E. Runde	J. R. Williams	

	1970-1971	1971-1972	1972-1973	1973-1974
President	A. R. Dahlberg	T. L. Fuller		
1st V.-Pres.	T. L. Fuller	N. D. Bryant		
2nd V.-Pres.	N. D. Bryant	E. E. Runde		
3rd V.-Pres.	E. E. Runde	J. J. Ridgeway		
Secretary	Ann Wilson	Ann Wilson		
Treasurer	W. H. Huffman	W. H. Huffman		
Directors	T. A. Reynolds	J. W. Chambers		
	J. J. Ridgeway	R. E. Frame		
	J. R. Williams	J. C. Hobbs		
	J. W. Chambers	R. K. Corbett		
	R. E. Frame	J. R. Iwinsky		
	J. C. Hobbs	J. S. Pritchett		
	R. K. Corbett	D. C. Gould		
	J. R. Iwinsky	W. S. Stokely		
	J. S. Pritchett	W. C. Sturm		

CONSTITUTION

ARTICLE I.

NAME

Section 1. This association shall be known as the American Railway Bridge & Building Association.

ARTICLE II.

OBJECT

Section 1.** The object of this association shall be the advancement of knowledge pertaining to the design, construction and maintenance of railway bridges, buildings, water service facilities, and other structures, by investigation, reports and discussions.

Section 2. The association shall neither indorse nor recommend any particular devices, trade marks or materials, nor will it be responsible for any opinions expressed in papers, reports or discussion unless the same have received the endorement of the association in regular session.

ARTICLE III.

MEMBERSHIP

Section 1. The membership of this association shall be divided into five classes, viz: Members, life members, associate, honorary and junior members.*

Section 2.** A member shall be a person in a position above rank of gang foreman in connection with roadway bridge, building and water service work, or in the employ of a public regulatory body, a professor of engineering in a college, an engineering editor, or a government or private timber expert. Any person desirous of becoming a member shall make application upon the form prescribed by the executive committee, setting forth his name, age, residence and practical experience. He shall furnish at least three references to whom he is personally known. Applicants may be voted into membership at any regular executive meeting or by letter ballot of the executive committee, a majority vote being necessary in either instance.

Section 3.** To be eligible for a life membership a member must have belonged to the association for at least 15†† years and in general must have retired from active railway service due to age or physical disability. He shall have all the privileges of active membership, except the holding of office, and shall not be required to pay annual dues. The transfer from membership to life membership shall be made in the same manner as the election of members, as prescribed in Section 2, of this Article.

Section 4. Associates shall be responsible persons who are not eligible as members, whose pursuits or attainments qualify them to co-operate with members in the study and development of improved practices in the construction and maintenance of bridges, buildings and water facilities. They shall have all the rights of members except of voting and holding office. They shall be elected in the manner prescribed for members, in Section 2 of this Article.

Section 5. Honorary members shall be chosen from persons who have attained acknowledged eminence in some branch of engineering or railway service. Their number shall be limited to ten. Honorary members shall be proposed by not less than six active members and shall be elected by the unanimous vote of the members present at a regular meeting. They shall have all the rights of active members except that of holding office and shall be exempt from the payment of dues.

Section 6. A junior member shall be a person who is a graduate of a recognized engineering school, or who has been employed for at least two years in the design, maintenance or construction of railway bridges, buildings or structures. Applicants shall be at least 21 years of age and they shall be elected in the manner prescribed for members, in Section 2 of this article. Juniors shall have all the rights of members except that of holding office. When the attainments of a Junior are such as to qualify him as a member, he may apply for promotion and the executive committee shall authorize such promotion when qualifications warrant the action. Unless a Junior is promoted, his membership shall cease automatically when he becomes 28 years of age.*

* Amended October 16, 1941.
** Amended September 20, 1948
†† Amended March 10, 1958.

Section 7. Any member guilty of conduct unbecoming to a railroad officer and a member of this association, or who shall refuse to comply with the rules of this association, shall forfeit his membership on a two-thirds vote of the executive committee.

Section 8. Membership shall continue until written resignation is received by the secretary, unless member has been previously expelled, or dropped for non-payment of dues in accordance with Section 1 of Article VII.

Section 9.** Only active members shall hold office in this association, and only active and life members shall be entitled to vote in the election of officers.

ARTICLE IV.

OFFICERS

Section 1§. The officers of the Association shall be a president, three vice-presidents, a secretary, a treasurer and nine directors, who, with the most recent past president, shall constitute the Executive Committee.

Section 2. The past presidents of this association, previous to the most recent past president, who continue to be members shall be privileged to attend all meetings of the executive committee, at which meetings they shall receive due notice, and be permitted to discuss all questions and to aid said committee by their advice and counsel; but said past presidents shall not have a right to vote, unless called upon to fill a quorum.

Section 3. Vacancies in any office shall be filled for the unexpired term by the executive committee without delay.

ARTICLE V.

EXECUTIVE COMMITTEE

Section 1.** The executive committee shall manage the affairs of the association and shall have full power to control and regulate all matters not otherwise provided for in the constitution and by-laws and shall exercise general supervision over the financial interests of the association, and make all necessary purchases and contracts required to conduct the general business of the association, but shall not have the power to render the association liable for any debt beyond the amount then in the treasury plus accounts receivable and not subject to other prior liabilities. All appropriations for special purposes must be acted upon at a regular meeting of the association.

Section 2. Meetings of the executive committee may be called by a majority of the members of the committee, providing 10 days' notice is given members by mail.

Section 3. Five members of the executive committee shall constitute a quorum for the transaction of business.

ARTICLE VI.

ELECTION OF OFFICERS AND TENURE OF OFFICE

Section 1. Except as otherwise provided the officers shall be elected at the regular annual meeting of the association and the election shall not be postponed except by unanimous consent of the members present at said annual meeting. The election shall be by ballot, a majority of the votes cast being required for election. Any active member of the association not in arrears for dues shall be eligible for office, but the president shall not be eligible for re-election.

Section 2.§ The president, three vice-presidents, secretary and treasurer shall hold office for one year and the directors for three years, three directors being elected each year. All officers shall retain their office until their successors are elected and installed. A director elected for a three-year term shall not be eligible to serve two consecutive terms.

Section 3.† The term of office of the secretary and the treasurer may be terminated at any time by a two-thirds vote of the executive committee. Their compensation shall be fixed by a majority vote of the executive committee.

The secretary shall also serve as secretary of the executive committee.

Section. 4. The secretary and the treasurer shall be required to give bond in an amount to be fixed by the executive committee.

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* Amended October 16, 1941.
† Amended September 21, 1957.
§ Amended September 28, 1966.

ARTICLE VII.

MEMBERSHIP FEE AND DUES

Section 1.† Every member upon joining this association shall pay to the secretary an entrance fee and dues as prescribed by the executive committee. No member in arrears for annual dues shall be entitled to vote at any election and any member more than one year in arrears, may be stricken from the list of members at the discretion of the executive committee.

Section 2.‡ A person stricken from the list of members because of non-payment of dues, upon written application may be reinstated as a member in his former class without loss of privileges, either upon payment of all back dues (which must accompany applicants) or at the discretion of the executive committee voting in the manner prescribed in Section 2, Article III.

ARTICLE VIII.*

LOCAL SECTIONS

Section 1.** Upon the application of ten or more members of the association residing in the same geographical district, or having offices therein, the executive committee shall organize a local section for that district, to which all members in that district shall be eligible. Such local section shall admit to active membership only members in good standing. It shall hold not less than two meetings each year, and shall be governed by such constitution and by-laws not inconsistent with the constitution of this association as the section membership may adopt and the executive committee approve.

Section 2. The parent association shall not be put under any obligation, either financial or in the matter of policy or opinion, by any local section.

ARTICLE IX.

AMENDMENTS

Section 1. This constitution may be amended at any regular meeting by a two-thirds vote of the members present, provided that notice of the proposed amendment or amendments has been sent to the members at least 30 days previous to said regular meeting.

By-Laws

TIME OF MEETING

1.** The regular meeting of this association shall convene annually during the month of September, the exact date to be fixed by the executive committee.

PLACE OF MEETING

2.** The place of holding the annual convention shall be Chicago, Ill.

3. It shall be within the power of the executive committee to change the location or time of the meeting if it becomes apparent that it is for the best interests of the association.

QUORUM

4. At the regular meeting of the association, 15 or more members shall constitute a quorum.

***DUES

5. The annual dues for the fiscal year ending August 31, and payable in advance, shall be as follows:*

Members, $7.00; Associate Members, $7.00; Junior Members, $5.00.

DUTIES OF OFFICERS

6.† The president shall have general supervision over the affairs of the association. He shall preside at all meetings of the association and of the executive committee; shall appoint all committees not otherwise provided for, and shall be ex-officio mem-

† Amended October 17, 1940.
* Article adopted 1922.
** Amended September 20, 1948
‡ Amended September 21, 1957.
*** Amended September 15, 1965.

ber of all committees. He shall with the secretary sign all contracts or other written obligations of the association which have been approved by the executive committee. He shall render a detailed report at least three times during the year to the members of the executive committee, showing the financial condition of the association and its activities.

At the annual meeting the president shall present a report containing a statement of the general conditions of the association.

7. The vice-presidents in order of seniority shall preside at meetings in the absence of the president and discharge his duties in case of a vacancy in his office.

8.† It shall be the duty of the secretary to keep a correct record of the proceedings of all meetings of this association, and of all accounts, between this association and its members; to collect all moneys due the association, and deposit the same in the name of the association. He shall pay all bills when properly certified and approved by the president and the treasurer, and make such reports as may be called for by the executive committee. He shall also perform such other duties as the association may require.

9.‡ The treasurer shall have charge of the funds, check all deposits as made by the secretary, sign all checks after they have been approved by the president, and invest all funds not needed for current expenses as directed by the executive committee. He shall report at each annual meeting on the condition of the finances.

NOMINATING COMMITTEE

10.# After each annual meeting the president shall appoint a committee consisting of five members. Two Past Presidents shall be members of this committee, one of whom shall act as Chairman. No other officers of the Association shall be appointed to this committee. This committee shall prepare a list of names of nominees for officers to be voted on at the next annual convention in accordance with ARTICLE VI of the Constitution, said list to be read at the business session of said convention. Nothing in this section shall be construed to prevent any member making further nominations.

AUDITING COMMITTEE

11.‡ Prior to each annual meeting the president shall appoint a committee of three members, not officers of the association, whose duty it shall be to examine the accounts and vouchers of the secretary and the treasurer and certify as to the correctness of their accounts.

COMMITTEE ON SUBJECTS FOR DISCUSSION

12. After each annual meeting the president shall appoint a committee whose duty it shall be to prepare a list of subjects for investigation to be submitted for approval at the next convention.

COMMITTEE ON INVESTIGATION

13. After the association has adopted the list of subjects for investigation the president for the succeeding year shall appoint the committees who shall prepare the subjects for report and discussion. He may also appoint individual members to prepare reports on special subjects, or to report on any special or particular subject.

PUBLICATION COMMITTEE

14. After each annual meeting the executive committee shall appoint a publication committee consisting of three active members whose duty it shall be to cooperate with the secretary in the issuing of the publications of the association. The assignment of this committee shall be such that at least one member shall have served on the committee during the previous year.

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‡ Adopted October 17, 1940.
# Amended December 4. 1950.
† Amended September 20, 1948.
‡ Amended September 21, 1957.

ORDER OF BUSINESS

15.† Call to order by president.
Opening prayer or invocation.
President's address.
Report of secretary.
Report of treasurer.
Appointment of special committees.
Reports of standing committees and presentation of papers.
Unfinished business.
New business.
Election of officers.
Installation of officers.
Adjournment.

DECISIONS

16. The votes of a majority of the members present shall decide any questions. motion or resolution which shall be brought before the association, unless otherwise provided. Unless specifically provided herein otherwise, all discussions shall be governed by Robert's rules of order.

AMENDMENTS

17.† The By-Laws can be amended by a two-thirds vote of those present at any regularly called executive committee meeting.

† Amended September 20, 1948.

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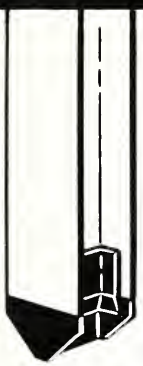

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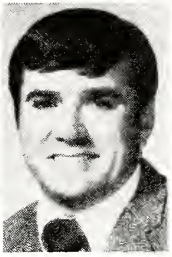

T. M. Evans
1555 Springfield Court
Dunwoody, GA 30338

F. E. Gonzalez
75 Forestwood Lane, N.E.
Atlanta, GA 30328

F. A. Holmes
118 Blueberry Hill
Surry Farms
Los Gatos, CA 95030

W. H. Hudson, Jr.
15003 Glade Brook Drive
Houston, TX 77069

J. E. Prendergast
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West Chester, PA 19380

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INDUSTRIAL HERBICIDES

DIRECTORY OF MEMBERS

As of April 1, 1973

HONORARY MEMBERS

Benson, G. W.
Curie, H. D.
Dick, M. H.
Dove, R. E.
Gunderson, R. R.
Howard, N. D.
Jorlett, J. A.
Mottier, C. H.
Strate, T. H.
Winkelhaus, L. C.

LIFE MEMBERS

Anderson, Arthur
Babcock, D. L.
Baker, F. A.
Baker, R. C.
Beaver, J. F.
Beeder, R. H.
Bell, D. V.
Benson, O. C.
Beringer, M. A.
Billmeyer, E. D.
Bishop, D. B.
Block, M.
Bowman, R. M.
Bradfield, R. G.
Brice, W. T.
Buckmaster, W. A.
Budzenski, F. N.
Bunge, W. H.
Burch, E. E.
Burpee, C. M.
Carpenter, R. H.
Carter, J. W.
Chamberlain, P. C.
Christianson, H. B.
Collier, P. B.
Colvin, A. A.
Cramer, F. H.
Cross, E. T.
Davis, H. E.
Decker, H. H.
Duchac, J. V.
Eargle, J. M.
Eichenlaub, C. M.
Elliott, C. E.
Enger, E. M.
Engman, V. E.
Forseth, C. E.
Fort, O. E.
Fox, R. L.
Fronabarger, H. C.
Frost, L. M.
Geyer, C. J.
Giles, J. M.
Harlow, H. M.
Harman, W. C.
Hedley, W. J.
Heinlen, R. H.
Hemstad, Birger
Hendrix, W. P.
Hickok, B. M.
Hillman, A. B.
Hornig, F. F.
Hoyt, A. C.
Hubbard, M. J.
Hutcheson, F. W.
Hutcheson, W. A.
Jackson, T. E.
Jenkins, H. W.
Johnson, A. C.
Johnson, B. O.
Johnson, E. A.
Johnson, R. W.
Jones, A. C.
Kemmerer, W. G.
Kendal, J. T.
Kieckers, E. W.
Koehler, P. L.
Krefting, A. S.
Kvenberg, S. E.
Leach, A. L.
Linn, G. A.
Lokotzke, G. P.
Lord, H. L.
Lucas, H. F.
Lund, C. V.
McGrew, F. O.
Manley, B. F.
Martens, W. F.
Mason, S. K.
Mateer, W. G.
Mayfield, Lee
Meeks, W. R.
Merrill, B. W.
Meyers, B. R.
Moore, I. A.
Morgan, C. E.
Moris, R. F.
Nichols, J. C.
Oest, W. C.
Packard, B. G.
Pahl, W. H., Jr.
Pearson, A. H.
Peterson, N. E.
Podas, N. F.
Pritchard, B. L.
Raessler, V. D.
Rainey, W. H.
Rapier, L. F.
Raver, H. E.
Richards, C. A. J.
Robinson, G. E.
Robinson, N. R.
Rothell, R. D.
Safley, J. R.
Salmon, J. M., Jr.
Sathre, C. O.
Saunders, T. D.
Singer, E. W.
Slagle, G. P.
Smith, C. E.
Smith, E. L.
Smith, H. E.
Smith, J.
Stephens, B. M.
Switzer, G.
Taylor, W. L.
Tetrault, L. J.
Thelander, P. V.
Throckmorton, W. B.
Todd, D. C.
Tourtellotte, E. B.
Trulove, J. D.
Tucker, N. R.
Tyckoson, E. G.
Von Behren, G.
Wachter, C. E.
Wall, R.
Wang, A. B.
Warfield, H., Jr.
Warfield, W. B.
White, L. H.
White, S.
Whitehouse, B. M.
Wingerson, C.
Wohlschlaeger, M. A.
Wood, R. E.
Woolford, F. R.
Yaw, D. W.
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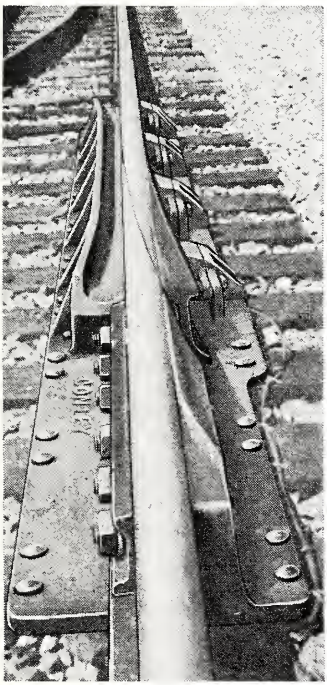

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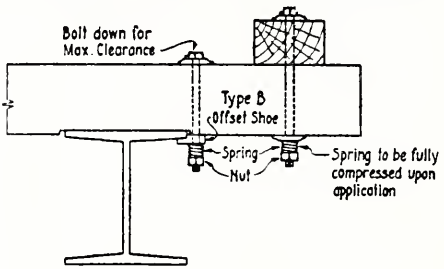

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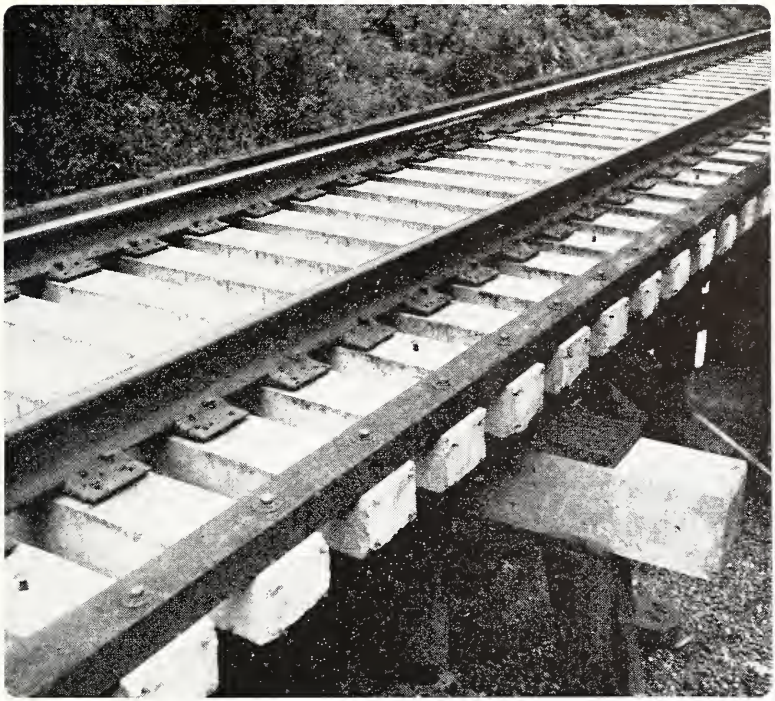

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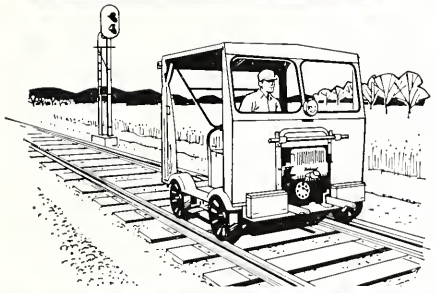

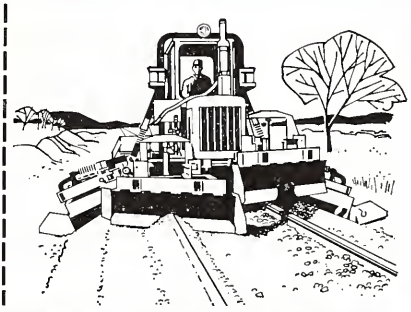

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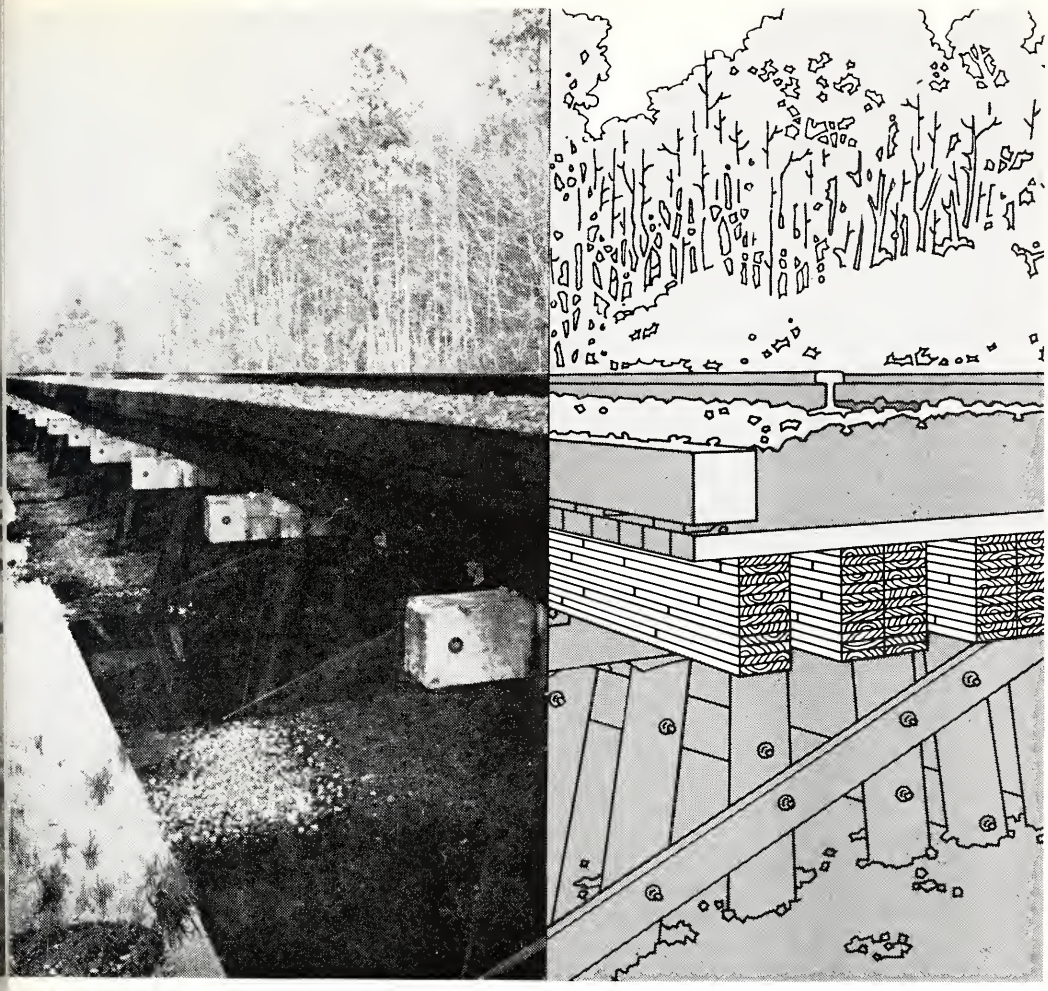

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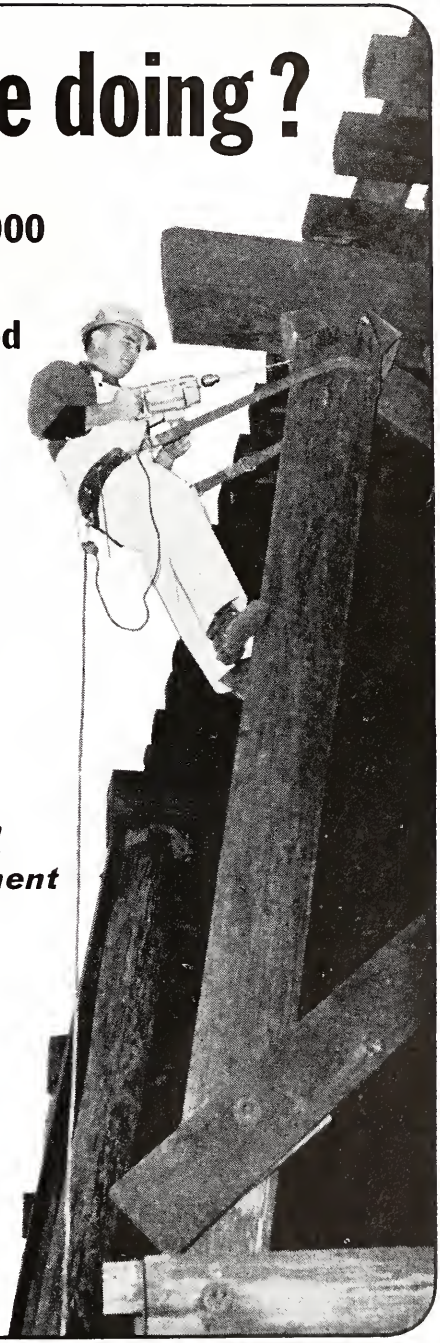

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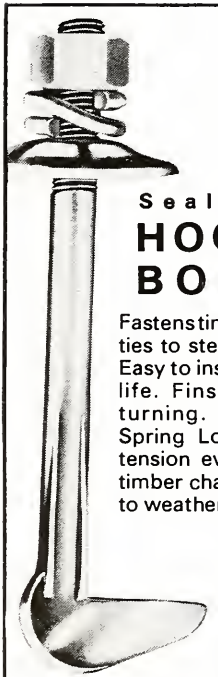

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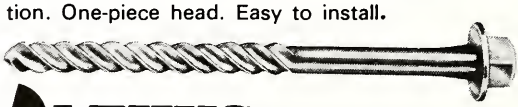

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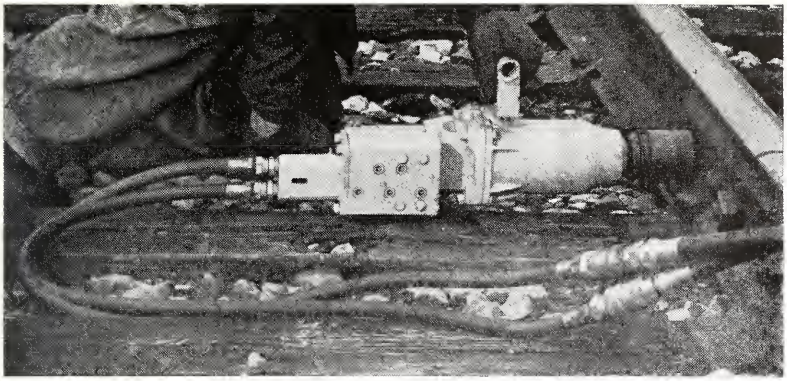

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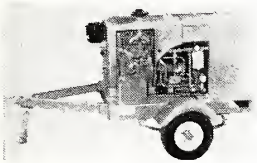

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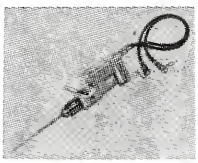

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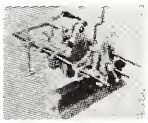

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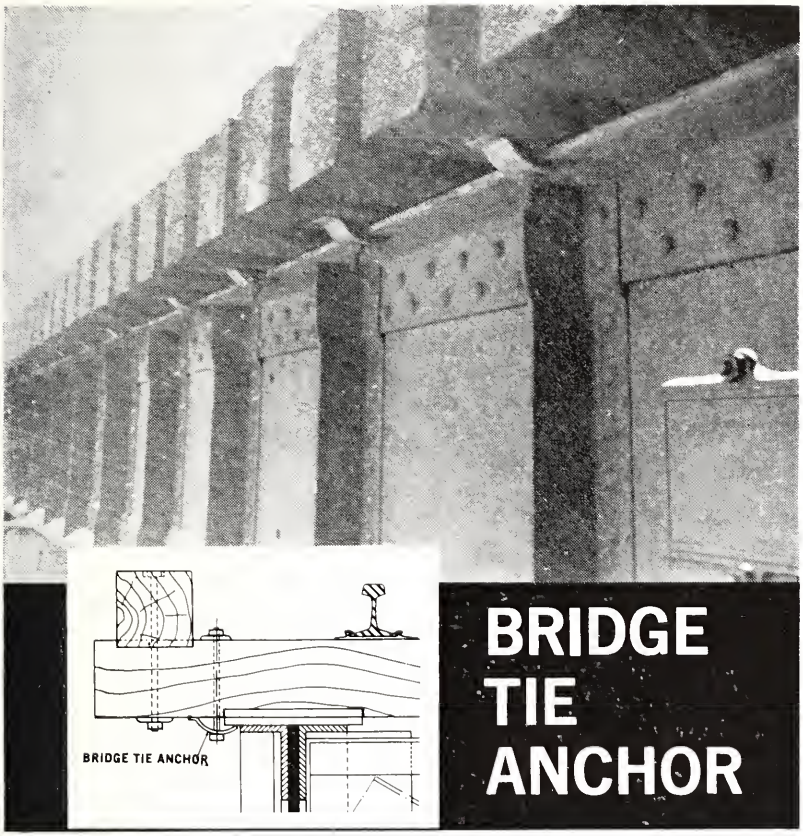

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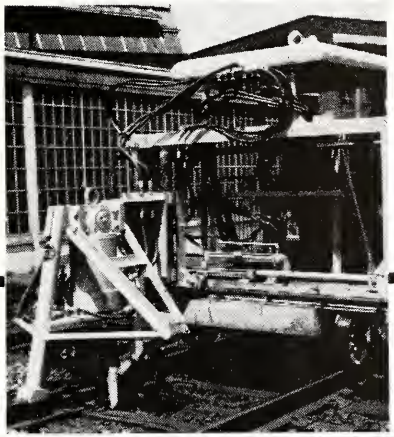

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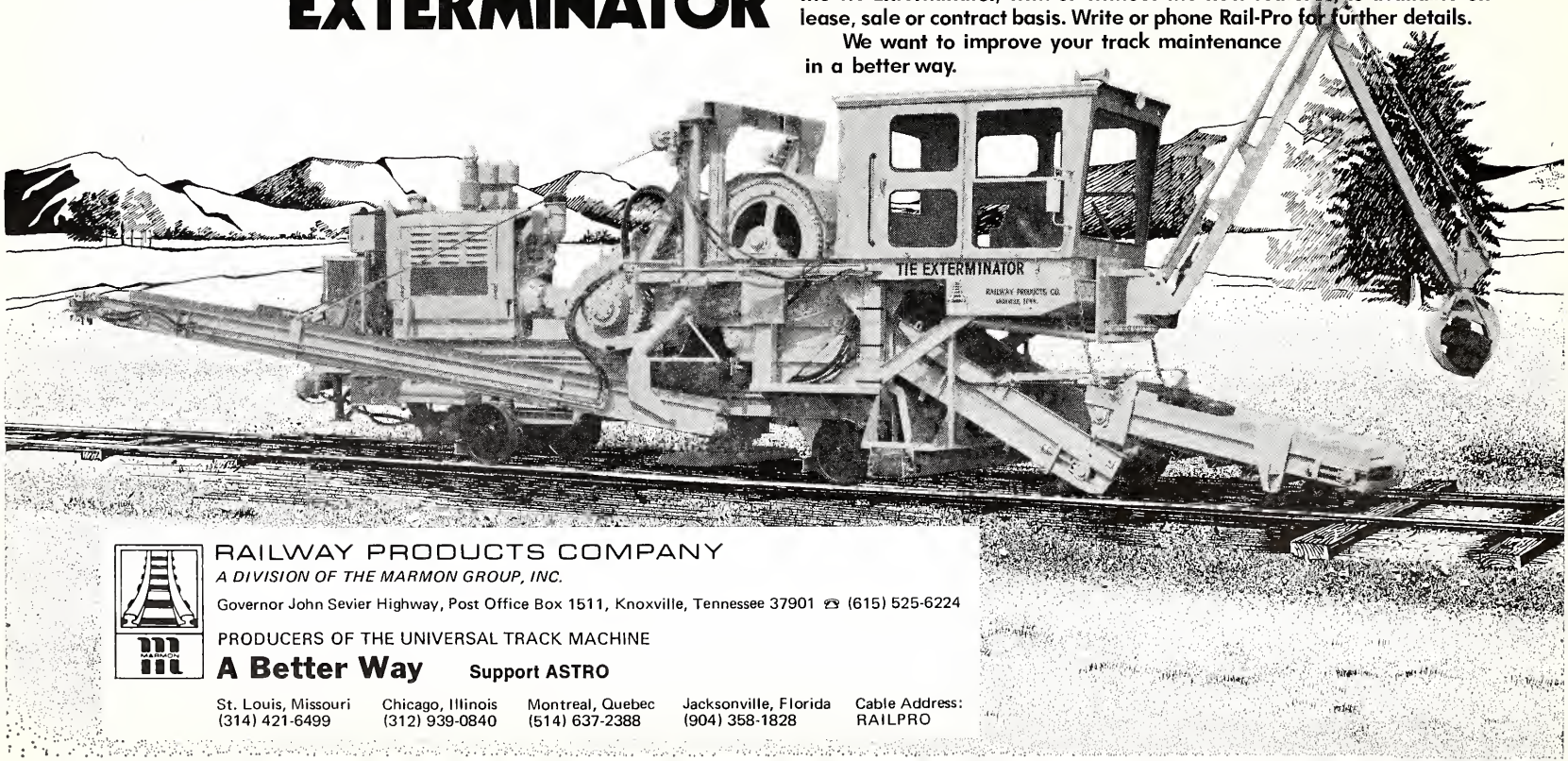

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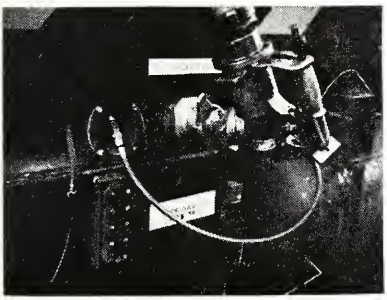
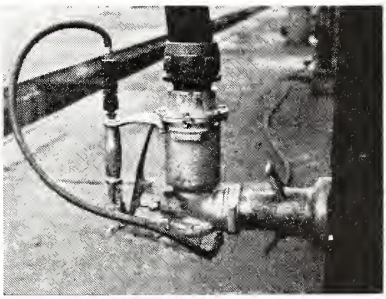


Close-Up of Snyder OPW 1620-DS Automatic Nozzle in operation, with Snyder No. 565 Quarter Turn Fuel Quick Coupling Adapter, connected to Standard Diesel Fuel Tank. Fill Adaptor.



Close-Up of Snyder OPW 1620-DS Automatic Nozzle secured, with Snyder No. 565 Quick Coupling Fuel Adaptor to No. 104-S Fuel Crane.

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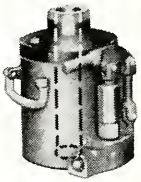

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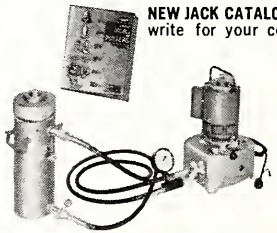

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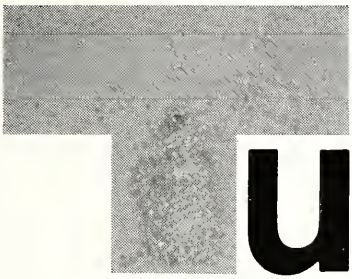

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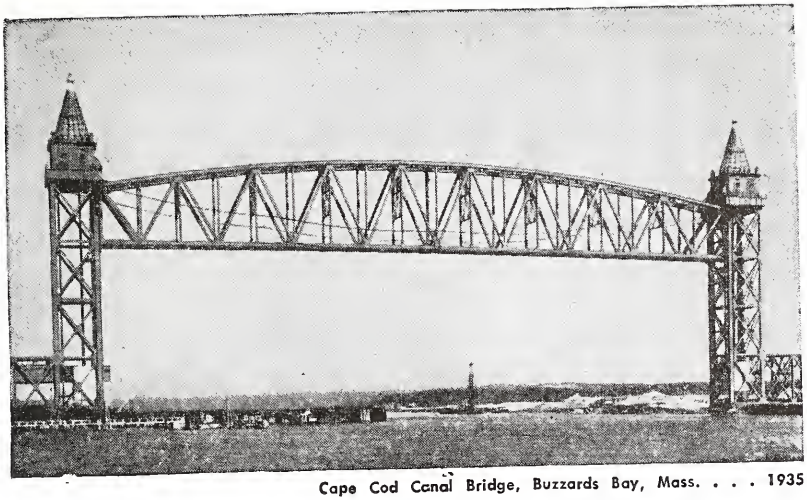

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